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BULLETIN 11

MUNICIPAL ELECTRIC FIRE ALARM AND POLICE PATROL SYSTEMS

WASHINGTON
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LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF THE CENSUS,
Washington, D. C., May 31, 1904.

SIR:

I have the honor to transmit herewith a bulletin on the application of the electric telegraph and telephone to the fire alarm and police patrol systems of the cities of the United States, prepared under the direction of Mr. W. M. Steuart, chief statistician for manufactures. These statistics have been compiled in accordance with the provisions of section 7 of the act of Congress of March 6, 1902. This bulletin is the third of a series of reports on the generation and utilization of electric current. The first report related to street and electric railways and the second to electric light and power plants, which were published as census bulletins 3 and 5, respectively. Subsequent reports will present statistics for the commercial telephone and telegraph systems, including ocean cable companies.

The schedules for this report were collected entirely by correspondence, and the Bureau is to be congratulated upon the prompt attention given by the city officials to its requests for information. Complete reports were received for all cities in which the systems were known to be in existence, with the exception of a few unimportant towns, in some of which the commercial telephone companies were utilized by the fire alarm and police patrol systems, there being no system operated for the exclusive benefit of the municipality. The statistics were compiled by the regular clerical force of the Bureau, and the text prepared by Mr. Thomas Commerford Martin, of New York city, expert special agent.

The schedules of inquiry used in this investigation were designed to secure information concerning the construction and equipment of the two systems and the amount of service rendered during the year ending December 31, 1902; also the number of persons employed exclusively in the management, care, or operation of the electrical department of the systems, and their salaries and wages. It was found, however, that as a rule the employees engaged in operating the fire alarm and police patrol systems were also employed in connection with other features of the service. As it was impossible to segregate in such cases the time devoted to the electrical part of the systems and the salaries received for such work, the statistics of employees and wages are presented only for the systems in cities of 100,000 population and over where a separate force of employees were engaged exclusively in the operation and maintenance of the electric fire alarm and police patrol systems.

Very respectfully,

S. N. D. North
Director.

Hon. GEORGE B. CORTELYOU,
Secretary of Commerce and Labor.

MUNICIPAL ELECTRIC FIRE ALARM AND POLICE PATROL SYSTEMS.

By Thomas Commerford Martin.

ELECTRIC FIRE ALARM SYSTEMS.

The statistics included in this bulletin cover practically all municipal electric fire alarm systems in operation in the United States during any part of the year ending December 31, 1902. No previous inquiry of the kind has been made in the United States serving as a basis of comparison, and the present inquiry was restricted to systems depending upon the application of the electric telegraph or telephone. The present report deals with electric fire alarm systems and police patrol systems, which are frequently worked together in common by one board or department, but which are here treated, as far as possible, in separate categories; no cognizance was taken of fire brigades, engines, etc. The data presented refer exclusively to systems operated under municipal control, with the exception of the fire alarm system in use at the Rock Island Arsenal, Illinois, which is owned and operated by the United States Government.

The earliest records dealing with the subject show that fire alarms and fire extinction were matters which until the last century were left very largely to private and volunteer effort. But even in the days when the fire apparatus was manned by organized citizens or by persons acting upon the impulse of the moment, the appliances and the alarm systems were often owned or subsidized by the communities. Thus, fire wardens appear among the officials of New York city as early as 1683, since which time there has been a steady tendency to remove fire administration from private hands and concentrate it in those of the municipality. Nevertheless the present report, which includes the statistics of 764 systems, shows wide variations in the municipal methods adopted for the government of the fire alarm and fire extinction service. The boards or departments of administration to which these systems were intrusted are shown in the following table:

Table 1.—*Electric fire alarm systems, grouped according to boards or departments of administration: 1902.*

BOARDS OR DEPARTMENTS OF ADMINISTRATION.	Systems.
Total	764
Administrative bodies	341
Board of aldermen and police and fire commissioners	1
Board of assessors	2
Board of commissioners for public utilities	10
Board of fire commissioners (or commissioner)	62
Board of fire engineers	67
Board of public safety	36
Board of public works	6
Board of selectmen and board of engineers	1
Board of trustees elected by voluntary firemen	2
Chief of fire department and city electrician	2
City council and chief of fire department	4
City council and fire marshal	5
City council and superintendent of fire and police departments	1
Committee appointed by citizens at town meetings	2
Department of electricity	21
Department of fire and police patrol telegraph	1
Department of police and public property	1
Department of wire inspection	2
Fire and police board	1
Fire and water committee of the sanitary improvement commission	1
Fire department (chief, committee, or director of)	141
Fire marshal	2
Joint board of fire wardens and selectmen	1
Mayor and city council	20
Mayor, city council, and fire department	1
Ordnance Department of United States Army	1
Police and fire commission	12
Police and fire department	1
Superintendent of fire alarm and police patrol telegraph	4
Water department	1
Water and light department	1
Not reported	10

From this table it appears that 341 fire alarm systems, or nearly 50 per cent of the total number, were under the direction of administrative bodies; these included boards of aldermen, boards of selectmen, city councils, boards of burgesses, trustees, etc.—bodies which are almost universally of an elective character. In the larger cities of the United States, however, it is now an almost invariable rule that the fire department shall be administered by an officer or officers nominated and appointed by the mayor, with or without the confirmation of the city council. There is also a growing tendency to intrust the supervision of the fire alarm and police patrol systems, as well as of other electrical functions, to a department of electricity.

The authorities, other than administrative bodies, in charge of fire alarm systems include 141 fire departments, 67 boards of fire engineers, 62 boards of fire commissioners (or a single commissioner), 36 boards of public safety, 21 departments of electricity, 20 mayors with the assistance of the city council, and 12 police and fire commissions. This heterogeneity is due largely to the fact that so many of the fire alarm systems are in cities and towns of less than 25,000 population.

Table 2 shows the number of fire alarm systems installed during each year, from 1852 to 1902, inclusive.

TABLE 2.—*Electric fire alarm systems installed each year.*

YEAR.	Number.	YEAR.	Number.	YEAR.	Number.
Total	764	1886	22	1868	10
		1885	23	1867	4
1902	25	1884	11	1866	2
1901	19	1883	17	1865	3
1900	26	1882	10	1864	1
1899	25	1881	3	1863	....
1898	33	1880	10	1862	1
1897	32	1879	8	1861	....
1896	32	1878	5	1860	....
1895	36	1877	3	1859	....
1894	37	1876	6	1858	1
1893	53	1875	7	1857	....
1892	41	1874	8	1856	....
1891	50	1873	9	1855	1
1890	44	1872	3	1854	1
1889	44	1871	6	1853	....
1888	40	1870	9	1852	1
1887	38	1869	4		

It will be observed from the table that in the earliest decade, namely, from 1852 to 1862, only 4 systems of fire alarm telegraph were installed. From 1862 to 1872 greater activity was evinced, 40 systems being installed. The decade from 1872 to 1882 showed a still further increased appreciation and demand on the part of the public, no fewer than 62 systems being installed. The rate of increase was well maintained from 1882 to 1892, these ten years witnessing the installation of no fewer than 299 systems, or about 30 per year. In the eleven years from 1892 to 1902, inclusive, the number of new systems was proportionately greater, reaching 359, or nearly 33 new plants per year. In view of the fact that all the larger cities had already been equipped, the swelling number would indicate that as time has gone by the improvements of the system and the increasing introduction of automatic features have rendered the service available for many of the smaller communities.

No census records prior to 1902 are on file with regard to the municipal electric fire alarm systems of the United States, so that comparison with the statistics presented in Table 3 is not possible. This table shows the construction and equipment and number of fire alarms for cities of specified population.

TABLE 3.—ELECTRIC FIRE ALARM SYSTEMS, GROUPED ACCORDING TO POPULATION OF CITIES, AND THE PERCENTAGE EACH ITEM IS OF TOTAL: 1902.

	POPULATION GROUPS.						PER CENT OF TOTAL.				
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Number of systems	764	36	37	76	221	394	4.7	4.9	9.9	28.9	51.6
Overhead construction:											
Miles of pole line—											
Owned	2,798	869	350	262	524	793	31.1	12.5	9.4	18.7	28.3
Leased	10,952	2,682	1,123	1,818	2,877	2,452	24.5	10.2	16.6	26.3	22.4
Wire mileage—											
Total	28,202	14,172	2,755	2,866	4,475	3,934	50.3	9.8	10.1	15.9	13.9
Single wire	27,721	13,849	2,738	2,837	4,369	3,9.8	50.0	9.9	10.2	15.8	14.1
Single wire in cables	481	323	17	29	106	6	67.2	3.5	6.0	22.0	1.3
Underground construction:											
Street miles of conduit—											
Owned	414	378	19	5	10	2	91.3	4.6	1.2	2.4	0.5
Leased	445	316	46	25	51	7	71.0	10.3	5.6	11.5	1.6
Wire mileage—											
Total	11,433	10,647	461	127	177	21	93.1	4.0	1.1	1.6	0.2
Single wire	526	387	42	36	55	6	73.6	8.0	6.8	10.5	1.1
Single wire in cables	10,907	10,260	419	91	122	15	94.1	3.9	0.8	1.1	0.1
Number and character of boxes or signaling stations:											
Signaling	37,739	16,028	3,787	4,665	7,159	6,100	42.5	10.0	12.4	19.0	16.1
Number on poles or posts	34,776	14,880	3,357	4,242	6,609	5,688	42.8	9.6	12.2	19.0	16.4
All other	2,963	1,148	430	423	550	412	38.7	14.5	14.3	18.6	13.9
Annunciating	93	....	....	....	16	77	....	....	....	17.2	82.8
Number on poles or posts	84	....	....	....	16	68	....	....	....	19.0	81.0
All other	9	....	....	....	....	9	....	....	....	....	100.0
Special telephones	1,900	1,432	125	163	115	65	75.4	6.6	8.6	6.0	3.4
Fire alarms received	85,070	40,548	8,760	11,716	15,499	8,547	47.7	10.3	13.8	18.2	10.0
Central office equipment:											
Manual transmitters	155	91	10	18	25	11	58.7	6.5	11.6	16.1	7.1
Automatic transmitters	295	29	45	76	103	42	9.8	15.3	25.8	34.9	14.2
Receiving registers, all kinds	452	165	49	84	80	74	36.5	10.8	18.6	17.7	16.4
Receiving circuits	1,973	752	289	344	426	162	38.1	14.7	17.4	21.6	8.2
Transmitting circuits	1,361	440	265	259	297	100	32.3	19.5	19.0	21.8	7.4
Telegraph switchboards, number	214	55	21	35	71	32	25.7	9.8	16.3	33.2	15.0
Number of sections	259	84	25	36	81	33	32.4	9.7	13.9	31.3	12.7
Total capacity	2,407	1,401	212	225	463	106	58.2	8.8	9.4	19.2	4.4
Telephone switchboards, number	62	39	9	7	5	2	62.9	14.5	11.3	8.1	3.2
Number of sections	153	105	28	8	10	2	68.6	18.3	5.2	6.6	1.3
Total capacity	6,480	5,911	374	86	56	53	91.2	5.8	1.3	0.9	0.8
Single circuits	442	....	....	4	97	341	....	....	0.9	22.0	77.1
Central station power equipment:											
Engines—											
Number	7	2	1	....	1	3	28.6	14.3	....	14.3	42.8
Horsepower	58	50	2	....	1	5	86.2	3.5	....	1.7	8.6
Dynamos—											
Number	19	2	1	1	3	12	10.5	5.3	5.3	15.8	63.1
Horsepower	51	32	2	2	4	11	62.8	3.9	3.9	7.8	21.6
Motor generators and dynamotors—											
Number	81	58	8	3	5	7	71.6	9.9	3.7	6.2	8.6
Horsepower	47	22	3	9	5	8	46.8	6.4	19.2	10.6	17.0
Battery cells—											
Primary	57,010	23,189	4,735	4,793	10,713	13,580	40.7	8.3	8.4	18.8	23.8
Storage	49,327	16,364	10,469	8,960	9,629	3,905	33.2	21.2	18.2	19.5	7.9

The table shows a total of 764 systems, of which 36 were in cities having a population of 100,000 and over, 37 in cities of 50,000 and under 100,000, 76 in cities of 25,000 and under 50,000, 221 in cities of 10,000 and under 25,000, and 394 in cities and towns under 10,000. These systems had in the aggregate 2,798 miles of pole line owned and 10,952 leased, with a total wire mileage of 28,202 miles, consisting of 27,721 miles of single wire and 481 miles of single wire in cables, engaged in the receipt and distribution of fire alarms. That the practice of putting such important wires as those of the fire alarm telegraph underground has rapidly increased of late years is indicated by the fact that, in addition to this overhead construction, these systems included 414 miles of conduit owned and 445 miles leased by municipalities, giving shelter to 11,433 miles of wire, of which 526 miles were single wire and 10,907 miles were wire in cables; thus, out of a total wire mileage of 39,635 miles, 28.8 per cent was underground.

Distributed along the circuits thus enumerated, there were reported 37,739 signaling boxes or stations, of which 34,776 were installed on poles or posts, and 2,963 "all other," or those located in booths, buildings, etc. There were also 93 annunciating boxes reported. It has already been shown that there were 39,635 miles of wire in the systems, and as the total number of signaling stations and annunciating boxes was 37,832, the distribution of apparatus by means of which alarms can be sent in to the central office was evidently very nearly one to the mile of operative circuit. If to this signaling and annunciating apparatus be added the 1,900 special telephones reported, the stations would slightly exceed one per mile of wire. Over this apparatus and wire mileage 85,070 fire alarms are reported to have been sent or received during the year ending December 31, 1902, which would give an average of between two and three per station and per mile of wire. It will be understood, of course, that these figures for fire alarms sent in or received do not include retransmission from central over other circuits from headquarters to the scattered engine houses, hook and ladder companies, etc.; for this reason it is impossible to determine the aggregate number of alarms received, transmitted, repeated, etc., by the fire alarm departments. Nor can any definite inference be drawn with regard to the number of boxes per mile of circuit in regard to the density of population or of buildings, for the general reason that as a measure of safety and precaution it is the practice not to put adjacent boxes on the same circuit, the object being to prevent interruption of service on any given line of communication, and also to lessen the probability of any two boxes on the same circuit being "pulled" at once for the same fire.

Table 3 presents also a variety of data with regard to the central office equipment. By reference to the table it will be seen that there were 155 manual transmitters, 295 automatic transmitters, and 4o2 receiving registers of all kinds, grouped at the various central offices or fire headquarters. These were associated with 1,973 receiving circuits and 1,361 transmitting circuits, for the operation of which there have been installed 214 telegraph switchboards, with 259 sections and a total capacity of 2,407 circuits, working in cooperation with 62 telephone switchboards, with 153 sections, and a total capacity of 6,480 drops or lines. The single circuits extending from the headquarters and returning thereto were reported as 442 in number. There are a large number of so-called fire alarm systems that consist in ringing a central bell or merely blowing a shrill whistle at some well-known central point, and it is probable that such an arrangement exists in some localities for calling the police or the village constable. No so-called fire alarm or police patrol systems were considered by the Bureau of the Census as falling within the scope of the inquiry unless the calls were sent in through a box over a single circuit and received at a fire or police central where at least one receiving register or other device was located.

For the operation of the fire alarm systems reported a large variety of apparatus and methods are in use, although battery current is in all the main reliance and the chief source of energy supply. According to the returns included in Table 3, the central office power or current equipment in 1902 comprised 57,010 primary and 49,327 storage battery cells. The primary batteries are usually of simple type, depending merely upon the renewal of acid or of such materials as copper or zinc, and the storage batteries are charged, in most cases, from an exterior power plant. This is shown by the fact that among the 764 systems there were reported only 19 dynamos generating current, with a total capacity of 51 horsepower; 7 steam or gas engines, with a total capacity of 58 horsepower; and 81 motor generators and dynamotors, with a total capacity of 47 horsepower. From this it would also appear that certain of the dynamos generating current are engine driven, and that the others are driven by electric motors. In some instances the power plant installation is in the nature of a reserve or precautionary measure, to insure a supply of current to the circuits in case the ordinary sources of supply should be interrupted.

A further study of Table 3 reveals the fact that of the 442 single circuits all but 4 were reported for cities of less than 25,000 population, 97 being in cities of between 10,000 and 25,000, and 341 in cities of less than 10,000. Other details indicate that for the systems in cities of less than 25,000 population there is little central office equipment other than the receiving registers and automatic transmitters. Of the total underground wire mileage of 11,433 miles reported in 1902, 10,647 miles, or 93.1 per cent, were in cities having a population of 100,000 and over; a similar proportion prevailed

with respect to conduits. The distribution of the 28,202 miles of overhead wire construction, however, was very different, 14,172 miles, or 50.3 per cent, being found in cities of 100,000 population and over, and 8,409 miles, or 29.8 per cent, in cities of less than 25,000 population. Distributed along these 8,409 miles of overhead wire were 13,352 signaling and annunciating boxes or stations, or 35.3 per cent of the total number. The use of the telephone appears to be chiefly restricted to the larger cities. Only 7 out of 62 switchboards, and only 109 out of 6,480 drops, or telephone lines, were reported in cities of less than 25,000 population; whereas 39 of the switchboards and 5,911 drops were reported in cities of 100,000 and over. In most other respects this table reveals a general uniformity and similarity of equipment and practice in the fire alarm systems throughout the country, as measured by the per cent distribution among the different population groups.

In connection with the use of the telephone for fire alarms it may be noted that it has been the practice of the Wisconsin Telephone Company, of Milwaukee, to suggest in its telephone directory that patrons send in fire alarms by telephone. The chief of police has lately requested the manager of the company to omit this suggestion from the book hereafter, for the reason that it frequently takes too long a time to notify the fire headquarters by telephone. This delay, he states, gives the fire a chance to gain headway before the department is able to respond to the call.

The percentage each item is of the total is also shown in Table 3. As might be expected, the percentages show that in the smaller communities, where for reasons of economy it is not feasible nor desirable to employ a large fire alarm staff, automatic transmitters preponderate, these percentages being 25.8, 34.9, and 14.2, respectively, in the three smallest population groups, whereas in respect to the use of manual transmitters 58.7 per cent are in use in the one group of cities having a population of 100,000 and over and nearly 80 per cent in the three groups comprising a population of 25,000 and over. It is rather surprising, however, to note that the smallest cities report the largest proportions of all engines and dynamos, which would hardly be expected since a primary battery equipment is usually quite adequate in such cases, but the numbers dealt with are altogether too small to carry any particular significance. In fact, it will be noted that 51 per cent of all primary batteries and 45.6 per cent of the total number of storage batteries were for systems in cities of less than 50,000 population.

Table 4 presents a synopsis of the number of fire alarm systems which reported the different varieties of construction and equipment, grouped according to population of cities.

TABLE 4.—*Electric fire alarm systems reporting different varieties of construction and equipment, grouped according to population of cities: 1902.*

CHARACTER OF CONSTRUCTION AND EQUIPMENT.	NUMBER OF SYSTEMS, BY POPULATION GROUPS.					
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Overhead construction:[1]						
Pole line—						
Owned exclusively	114	4	4	3	21	82
Leased exclusively	509	18	23	50	157	261
Owned and leased	139	13	10	23	43	50
Overhead construction exclusively	681	5	24	63	202	387
Underground construction:[2]						
Conduit—						
Owned exclusively	19	6	5	2	4	2
Leased exclusively	53	14	8	11	15	5
Owned and leased	9	9	......	......	......	......
Both overhead and underground construction	83	31	13	13	19	7
Boxes or signaling stations:[3]						
Signaling boxes exclusively	752	36	37	76	220	383
Annunciating boxes exclusively	9	......	......	......	1	8
Both signaling and annunciating boxes	1	......	......	......	......	1
Special telephones	104	24	9	18	27	26
Central office equipment:						
Manual transmitters exclusively	43	16	1	5	13	8
Automatic transmitters exclusively	214	8	28	56	87	35
Both manual and automatic transmitters	43	12	8	9	11	3
Receiving registers, all kinds	182	29	20	32	53	48
Receiving circuits	322	35	37	72	124	54
Transmitting circuits	255	35	32	56	93	39
Both receiving and transmitting circuits	255	35	32	56	93	39
Telegraph switchboards exclusively	146	4	13	28	70	31
Telephone switchboards exclusively	21	11	3	2	4	1
Both telegraph and telephone switchboards	30	18	6	4	1	1
Single circuits exclusively	442	......	......	4	97	341
Central station power equipment:						
Engines	5	1	1	......	1	2
Dynamos	14	1	1	1	3	8
Motor generators and dynamotors	24	8	2	3	5	6
Engines, dynamos, motor generators, and dynamotors	1	1	......	......	......	......
Dynamos, motor generators, and dynamotors	7	1	......	1	1	4
Battery cells—						
Primary	522	19	18	34	140	311
Storage	270	29	29	48	88	76
Both primary and storage	44	13	10	7	9	5

[1] One system failed to report the miles of pole line owned or leased, and one system failed to report pole line and wire mileage.
[2] Two systems failed to report the miles of conduit owned or leased.
[3] Two systems reported only telephoning boxes, which are not shown in this table.

From this interesting table it will be observed that of the 764 fire alarm systems in the United States, 681 used overhead construction exclusively, and of this number 387, or over 50 per cent, were to be found in communities of less than 10,000 population. This confirms the statement as to the extension of municipal fire alarm systems in the smaller cities and towns. There were 83 systems which used combined overhead and underground construction. There were only 114 municipalities which owned their entire pole line, while 509 leased, or used without cost, the supports for their overhead wires and cables.

Table 5 shows the miles of conduit and the wire mileage for the 83 systems reporting the use of underground construction.

Table 5.—UNDERGROUND CONSTRUCTION OF ELECTRIC FIRE ALARM SYSTEMS, BY STATES AND CITIES: 1902.

STATE OR CITY.	STREET MILES OF CONDUIT.		WIRE MILEAGE.		
	Owned.	Leased.	Total.	Single wire.	Single wire in cables.
United States	414	445	11,433	526	10,907
California	15	21	221	15	206
Los Angeles		10	54		54
Pasadena		1	2		2
San Francisco	15	10	165	15	150
Connecticut	30	8	143	127	16
Hartford	12		40	40	
New Britain	2		2	2	
New Haven	16	8	101	85	16
District of Columbia	1	6	760		760
Washington	1	6	760		760
Illinois	62	3	684		684
Bloomington	2		13		13
Chicago	54		640		640
Elgin		1	3		3
Evanston	6		24		24
Rockford		2	4		4
Indiana		5	58	3	55
Fort Wayne		1	6		6
Indianapolis		4	52	3	49
Maine		4	17		17
Portland		4	17		17
Maryland	(1)	(1)	42		42
Baltimore	(1)	(1)	42		42
Massachusetts	6	124	1,463	204	1,259
Boston	3	34	990		990
Brookline		19	50	31	19
Cambridge		1	3		3
Clinton		5	8	8	
Fall River	1		13		13
Haverhill		5	30	30	
Lexington		3	3	3	
Lowell		5	61		61
Milton		1	5		5
Nahant	1		1	1	
New Bedford		6	24		24
Newton		2	8	4	4
Springfield		18	120		120
Waltham		3	9		9
Westfield		3	3	3	
Winthrop	1		3		3
Worcester		19	132	124	8
Michigan	33	9	255	25	230
Bay City	3		7		7
Detroit	30		225	23	202
Jackson		3	10		10
Kalamazoo		3	7		7
Lansing		2	2	2	
Port Huron		1	4		4
Minnesota	2	19	315		315
Minneapolis	2	3	200		200
St. Paul		16	115		115
Missouri	4		455		455
St. Louis	4		455		455
Nebraska	(1)	(1)	23		23
Omaha	(1)	(1)	23		23
New Hampshire		5	14	2	12
Keene		1	2	2	
Nashua		4	12		12
New Jersey	1	18	156	2	154
East Orange		1	2		2
Long Branch		1	5		5
Montclair		1	1	1	
Morristown		1	1	1	
Newark		13	120		120
Paterson		1	24		24
Trenton	1		3		3
New York	134	30	1,380		1,380
Albany		3	25		25
Buffalo	2	5	168		168
Geneva	1		3		3
New York[2]	129	1	1,105		1,105
Rochester		13	50		50
Syracuse		3	15		15
Troy	2		4		4
Yonkers		5	10		10
Ohio		21	474		474
Akron		1	23		23
Canton		1	5		5
Cincinnati		9	195		195
Cleveland		5	80		80
Columbus		1	45		45
Toledo		4	126		126
Pennsylvania	85	137	4,353	53	4,300
Allegheny		84	252		252
Erie	2		11		11
Philadelphia	75	53	3,905	53	3,852
Pittsburg	8		185		185
Rhode Island	3	12	201		201
Newport		4	20		20
Providence	3	8	181		181
Tennessee		6	45		45
Memphis		6	45		45
Texas		7	26		26
Galveston		2	2		[3]2
San Antonio		4	20		20
Waco		1	4		4
Vermont		2	9	9	
Burlington		2	9	9	
Virginia		6	136		136
Norfolk		1	5		5
Richmond		5	131		131
Washington	2		2	2	
Seattle	2		2	2	
Wisconsin	36	2	201	84	117
Eau Claire	1		2		2
La Crosse		2	15		15
Milwaukee	35		184	84	100

[1] Not reported.
[2] Has 2 separate systems, but is treated as 1 system.
[3] City rents one or more wires in cable owned by private company.

It appears from the foregoing table that in the 83 systems included, 414 miles of conduits were owned and 445 miles were leased, giving a total of 11,433 miles of single wire and single wire in cables from which the streets have immediately been released. This underground circuit was more widely distributed than might perhaps be expected, being found in no fewer than 23 states and the District of Columbia. Nor can it be said that the larger cities were unduly represented; a glance at the table shows that New York, Boston, Chicago,

Philadelphia, and other large cities by no means preponderated in this respect. Further reference to this subject will be made incidentally in connection with underground police patrol wires.

Table 6 presents the number of employees and the total salaries and wages paid in 1902 in cities of 100,000 population and over in 1900, for both electric fire alarm and police patrol systems. Data are presented for 25 systems exclusively fire alarm, 21 systems exclusively police patrol, and 9 systems a combination of fire alarm and police patrol service, or a total of 55 systems.

TABLE 6.—*Employees and wages in cities of 100,000 population and over, electric fire alarm and police patrol systems: 1902.*

	Total.	Fire alarm exclusively.	Police patrol exclusively.	Combination fire alarm and police patrol.
Number of systems	55	25	21	9
Salaried officials and clerks:				
Total number	84	28	21	35
Total salaries	$139,477	$49,396	$32,294	$57,787
General managers, superintendents, etc.—				
Number	71	28	21	22
Salaries	$124,728	$49,396	$32,294	$43,038
Clerks and bookkeepers—				
Number	13			13
Salaries	$14,749			$14,749
Wage-earners:				
Total average number	818	305	291	222
Total wages	$804,065	$309,034	$270,903	$224,128
Operators, male—				
Average number	[1] 396	[1] 118	211	67
Wages	$401,659	$132,379	$201,204	$68,076
Foremen and inspectors—				
Average number	92	30	22	40
Wages	$100,666	$36,585	$20,361	$43,720
Linemen, wiremen, batterymen, etc.—				
Average number	289	123	54	112
Wages	$272,910	$114,945	$46,738	$111,227
All other employees—				
Average number	41	34	4	3
Wages	$28,830	$25,125	$2,600	$1,105

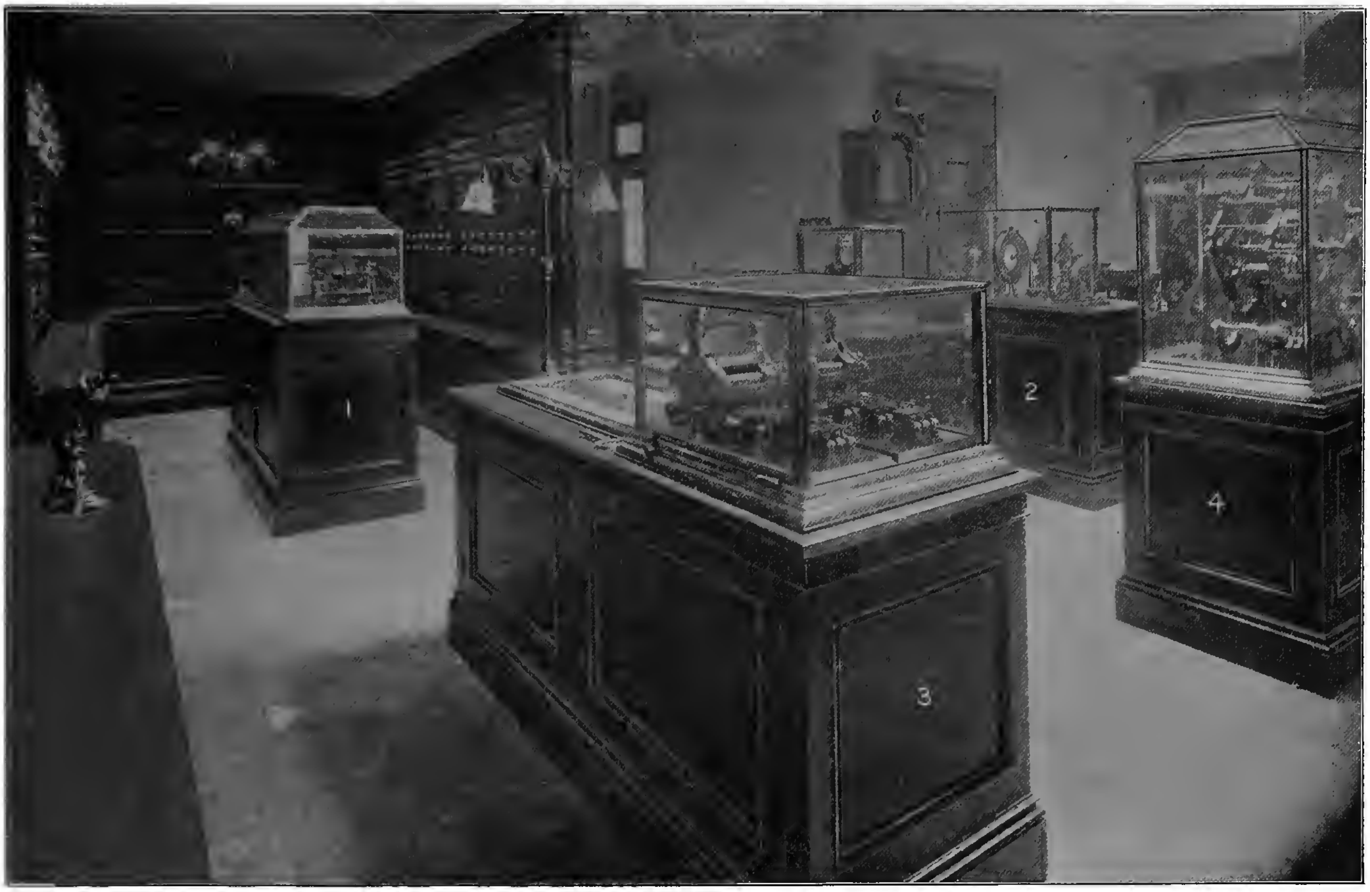
[1] Includes 1 female operator.

It will be gathered that the figures shown in the above table are representative rather than inclusive; at the same time they should not be understood as applying to the systems as a whole, owing to the fact that in so many of the smaller communities the duties which would fall to a fire alarm or police patrol service are merged in those performed by other officials in such a manner that the proportion of salaries or wages paid can not well be segregated according to the amount of work done or relative hours of duty in each department. The number of wage-earners shown in the table is the average number of each class continuously employed during the year in the operation and maintenance of the electrical department of the two systems.

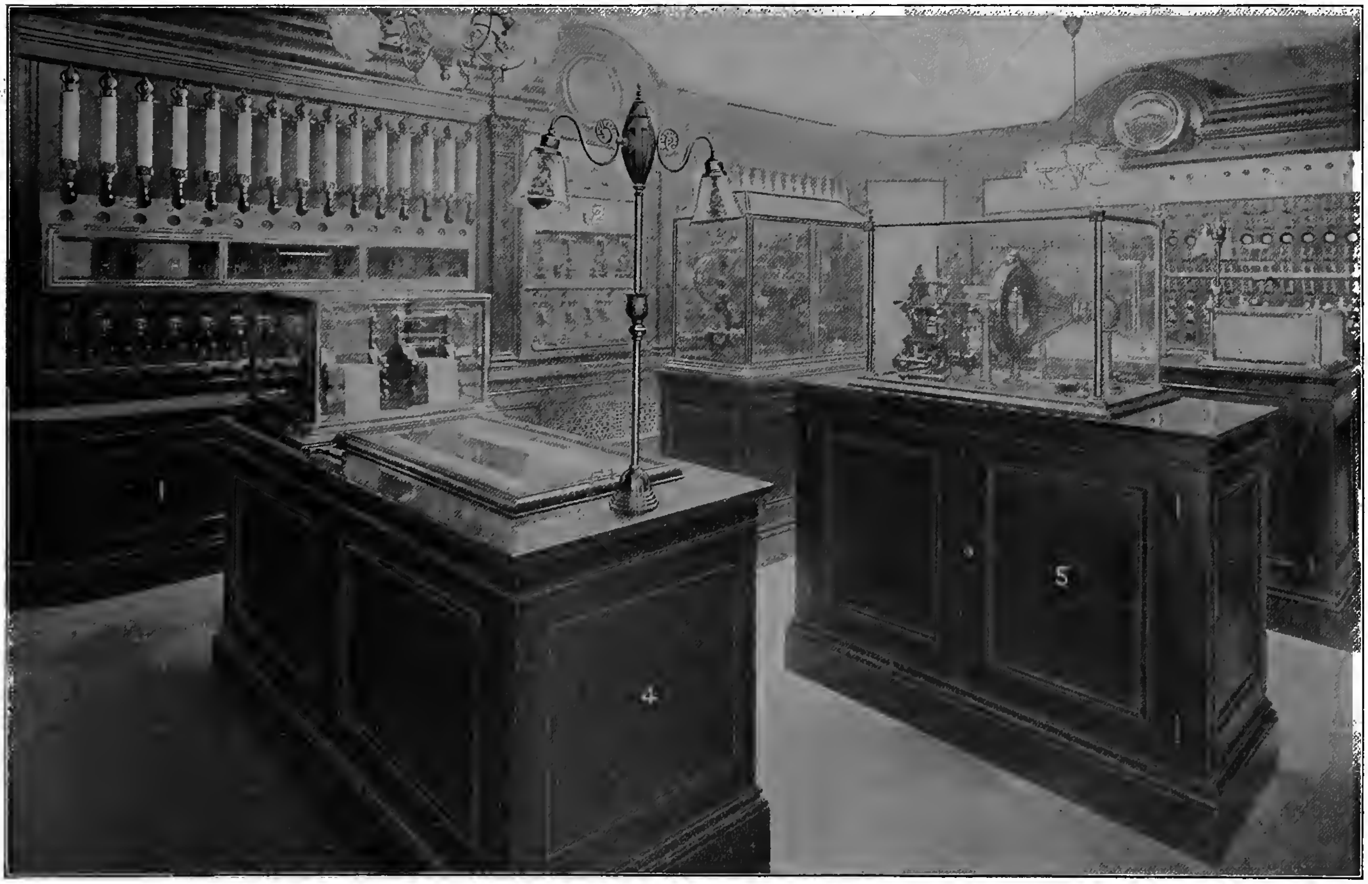
Of the 38 cities having a population of 100,000 or over, 2—Kansas City and St. Joseph, Mo.—had no systems of electric fire alarm; 2 did not report employees and wages, the systems being operated by local telephone companies on contract; and in 9 the fire alarm and police patrol systems were operated in conjunction and were reported in combination. In regard to the police patrol service, 4 of the 38 cities having a population of 100,000 or over—Louisville, Ky., New Orleans, La., Scranton, Pa., and Toledo, Ohio—had no electric systems; 1 failed to report employees and wages, and 3 were operated by local telephone companies on contract. The systems for 9 cities, as already noted, were operated in conjunction with fire alarm services and were reported in combination therewith.

That the services are already of some magnitude is indicated by the fact that the 55 systems included in this table show a total of 84 salaried officials and clerks, with total salaries of $139,477 per annum, and 818 wage-earners, with total wages of $804,065 per annum.

Table 7 is a detailed statement summarizing for each state all of the information with regard to constructional equipment of fire alarm systems, and also the number of alarms received.



1, Automatic repeater; 2, automatic line tester; 3, multiple pen register; 4, manual dial transmitter.



1, Relay switchboard; 2, joker board; 3, working switchboard; 4, multiple pen register; 5, automatic line tester.

TELEGRAPHIC DEPARTMENT, FIRE ALARM HEADQUARTERS, WASHINGTON, D. C., 1902.

TABLE 7.—ELECTRIC FIRE ALARM

	STATE OR TERRITORY.	Number of systems.	CHARACTER OF CONSTRUCTION. Overhead. Miles of pole line. Owned.	Overhead. Miles of pole line. Leased.	Overhead. Wire mileage. Total.	Overhead. Wire mileage. Single wire.	Overhead. Wire mileage. Single wire in cables.	Underground. Street miles of conduit. Owned.	Underground. Street miles of conduit. Leased.	Underground. Wire mileage. Total.	Underground. Wire mileage. Single wire.	Underground. Wire mileage. Single wire in cables.	NUMBER AND CHARACTER OF BOXES OR SIGNALING STATIONS. Signaling. Total number.	Signaling. Number on poles or posts.	Signaling. All other.	Annunciating. Total number.	Annunciating. Number on poles or posts.	Annunciating. All other.
1	United States	764	2,798	10,952	28,202	27,721	481	414	445	11,433	526	10,907	37,739	34,776	2,963	93	84	9
2	Alabama	6	4	79	112	112	...	...	...	...	...	...	195	192	3	...	...	...
3	Arizona	1	7	...	7	7	...	...	...	...	...	...	16	16	...	...	...	...
4	Arkansas	2	7	19	37	37	...	...	...	...	...	...	62	62	...	...	...	...
5	California	28	149	280	1,487	1,462	25	15	21	221	15	206	1,572	1,457	115	20	16	4
6	Colorado	12	42	145	219	219	...	...	...	...	...	...	397	368	29	...	...	...
7	Connecticut	26	55	381	569	569	...	30	8	143	127	16	1,014	813	201	...	...	...
8	Delaware	1	...	60	140	136	4	...	...	...	...	...	70	70	...	...	...	...
9	District of Columbia	1	(1)	(1)	(1)	(1)	(1)	1	6	760	...	760	307	261	46	...	...	...
10	Florida	7	6	48	88	88	...	...	...	...	...	...	179	178	1	8	8	...
11	Georgia	8	67	97	197	197	...	...	...	...	...	...	410	406	4	2	...	2
12	Idaho	1	10	...	10	10	...	...	...	...	...	...	10	10	...	...	...	...
13	Illinois	34	162	645	2,136	2,124	12	62	3	684	...	684	2,275	2,173	102	3	3	...
14	Indiana	37	87	645	935	885	50	...	5	58	3	55	1,400	1,296	104	9	9	...
15	Iowa	19	49	294	373	372	1	...	...	...	...	...	520	495	25	...	...	...
16	Kansas	8	33	71	120	120	...	...	...	...	...	...	183	172	11	...	...	...
17	Kentucky	12	29	149	299	299	...	...	...	...	...	...	587	464	123	16	16	...
18	Louisiana	3	...	113	423	423	...	...	...	...	...	...	321	321	...	...	...	...
19	Maine	22	11	227	367	366	1	...	4	17	...	17	481	443	38	...	...	...
20	Maryland	3	8	13	170	170	...	(1)	(1)	42	...	42	493	491	2	...	...	...
21	Massachusetts	106	311	1,791	3,867	3,808	59	6	124	1,463	204	1,259	4,890	4,385	505	...	...	...
22	Michigan	40	210	327	940	910	30	33	9	255	25	230	1,531	1,468	63	...	...	...
23	Minnesota	17	81	182	769	766	3	2	19	315	...	315	838	800	38	...	...	...
24	Mississippi	4	...	25	40	40	...	...	...	...	...	...	52	47	5	...	...	...
25	Missouri	3	83	38	1,802	1,788	14	4	...	455	...	455	1,097	1,038	59	...	...	...
26	Montana	3	9	15	39	39	...	...	...	...	...	...	57	56	1	...	...	...
27	Nebraska	5	6	113	181	151	30	(1)	(1)	23	...	23	172	171	1	...	...	...
28	Nevada	1	...	11	11	11	...	...	...	...	...	...	18	18	...	...	...	...
29	New Hampshire	18	11	180	320	316	4	...	5	14	2	12	419	373	46	...	...	...
30	New Jersey	57	185	565	1,070	1,060	10	1	18	156	2	154	1,779	1,664	115	15	15	...
31	New Mexico	2	...	9	9	9	...	...	...	...	...	...	30	30	...	...	...	...
32	New York	70[2]	371	1,103	3,557	3,356	201	134	30	1,380	...	1,380	5,578	4,915	663	16	13	3
33	North Carolina	9	32	44	95	87	8	...	...	...	...	...	196	194	2	...	...	...
34	North Dakota	4	5	18	23	23	...	...	...	...	...	...	54	51	3	...	...	...
35	Ohio	60	219	1,392	2,348	2,336	12	...	21	474	...	474	2,969	2,761	208	...	...	...
36	Oregon	2	...	32	63	63	...	...	...	...	...	...	128	118	10	...	...	...
37	Pennsylvania	56	387	719	3,238	3,232	6	85	137	4,353	63	4,300	3,566	3,408	158	...	...	...
38	Rhode Island	6	11	269	296	296	...	3	12	201	...	201	609	548	61	...	...	...
39	South Carolina	3	5	56	66	66	...	...	...	...	...	...	138	138	...	...	...	...
40	South Dakota	3	...	15	15	15	...	...	...	...	...	...	33	31	2	...	...	...
41	Tennessee	4	3	75	129	129	...	...	6	45	...	45	267	250	17	...	...	...
42	Texas	10	10	219	283	281	2	...	7	26	...	26	522	515	7	...	...	...
43	Utah	1	...	16	18	16	2	...	...	...	...	...	21	21	...	...	...	...
44	Vermont	11	3	78	101	101	...	...	2	9	9	...	231	217	14	...	...	...
45	Virginia	9	19	117	303	298	5	...	6	136	...	136	407	306	101	...	...	...
46	Washington	7	6	106	166	166	...	2	...	2	2	...	283	282	1	...	...	...
47	West Virginia	4	5	53	58	58	...	...	...	...	...	...	132	130	2	...	...	...
48	Wisconsin	26	94	316	698	696	2	36	2	201	84	117	1,220	1,143	77	...	...	...
49	Wyoming	2	6	2	8	3	...	...	...	...	...	...	10	10	...	4	4	...

[1] Not reported.

[2] New York city has 2 separate systems, but is treated as 1 system.

SYSTEMS, BY STATES: 1902.

Special telephones.	Fire alarms received.	Central office equipment. Transmitters. Manual.	Central office equipment. Transmitters. Automatic.	Central office equipment. Receiving registers, all kinds.	Central office equipment. Receiving circuits.	Central office equipment. Transmitting circuits.	Central office equipment. Telegraph switchboards. Number.	Central office equipment. Telegraph switchboards. Number of sections.	Central office equipment. Telegraph switchboards. Total capacity.	Central office equipment. Telephone switchboards. Number.	Central office equipment. Telephone switchboards. Number of sections.	Central office equipment. Telephone switchboards. Total capacity.	Single circuits.	Central station power equipment. Engines. Number.	Central station power equipment. Engines. Horsepower.	Central station power equipment. Dynamos. Number.	Central station power equipment. Dynamos. Horsepower.	Central station power equipment. Motor generators and dynamotors. Number.	Central station power equipment. Motor generators and dynamotors. Horsepower.	Central station power equipment. Battery cells. Primary.	Central station power equipment. Battery cells. Storage.	
1,900	85,070	155	295	452	1,973	1,361	214	259	2,407	62	153	6,480	442	7	58	19	51	81	47	57,010	49,327	1
8	838	......	4	3	17	7	2	2	12	......	......	......	2	......	......	......	......	......	......	176	405	2
1	70	1	......	3	4	2	......	......	......	......	......	......	......	......	......	......	......	......	......	49	......	3
......	305	......	1	11	7	4	1	1	4	......	......	......	......	......	......	......	......	......	......	178	26	4
58	2,661	4	12	19	82	50	15	23	122	4	9	125	17	......	......	1	1	1	1	7,140	2,126	5
6	1,295	......	3	2	16	14	......	......	......	1	1	6	9	......	......	......	......	......	......	376	667	6
33	1,183	3	12	4	52	78	6	7	44	1	1	25	15	......	......	......	......	......	......	1,610	1,597	7
......	80	......	1	1	6	6	......	......	......	......	......	......	......	......	......	......	......	......	......	50	450	8
......	786	1	2	3	30	14	......	......	......	2	3	250	......	......	......	......	......	1	1	......	906	9
6	349	2	1	2	18	10	1	1	4	......	......	......	4	......	......	......	......	......	......	200	312	10
6	1,191	1	3	1	28	20	3	3	26	......	......	......	4	......	......	......	......	......	......	255	956	11
......	50	......	......	......	......	......	......	......	......	......	......	......	1	......	......	......	......	......	......	50	......	12
148	9,027	28	12	42	78	63	8	8	24	5	6	311	22	......	......	......	......	20	7	1,657	1,684	13
3	3,648	3	6	13	71	56	6	10	73	3	6	110	25	......	......	......	......	......	......	2,312	1,043	14
26	1,807	......	8	26	36	33	4	5	135	......	......	......	10	......	......	......	......	......	......	542	1,133	15
2	512	1	1	1	8	6	1	1	4	......	......	......	5	......	......	......	......	......	......	461	......	16
32	1,864	4	6	6	25	24	1	1	2	1	34	50	5	......	......	......	......	......	......	971	13	17
53	511	1	2	1	22	21	3	3	26	1	1	100	......	......	......	......	......	......	......	125	967	18
......	940	......	6	2	27	14	5	5	48	......	......	......	17	......	......	......	......	2	2	917	1,158	19
30	1,053	31	2	1	31	6	1	1	50	1	7	1,920	2	......	......	......	......	......	......	78	127	20
245	9,491	14	50	71	318	250	33	35	554	5	6	144	50	7	58	9	40	43	14	5,024	11,311	21
108	2,830	8	17	17	64	33	6	6	58	3	3	115	24	......	......	1	2	1	1	1,292	2,505	22
45	2,430	2	3	15	55	26	7	7	64	5	5	116	12	......	......	1	1	......	......	380	2,358	23
......	239	......	2	1	8	1	......	......	......	......	......	......	2	......	......	......	......	......	......	152	90	24
246	2,272	2	1	1	42	20	15	15	185	2	2	150	2	......	......	......	......	1	1	1,371	......	25
......	85	......	1	......	2	......	......	......	......	......	......	......	2	......	......	......	......	......	......	202	......	26
17	585	1	3	1	9	7	2	2	8	1	1	5	2	......	......	......	......	......	......	136	418	27
......	27	......	......	......	......	......	......	......	......	......	......	......	1	......	......	2	1	1	1	......	50	28
......	787	......	7	8	33	19	4	7	25	......	......	......	11	......	......	......	......	1	1	834	571	29
87	3,306	6	15	13	78	72	11	14	88	5	9	196	41	......	......	1	1	2	2	2,706	2,754	30
......	48	......	......	......	......	......	......	......	......	......	......	......	2	......	......	......	......	......	......	72	4	31
254	12,794	11	30	79	261	127	24	44	355	5	6	173	39	......	......	1	3	2	6	10,005	4,411	32
2	434	......	3	......	13	6	1	1	3	......	......	......	6	......	......	......	......	......	......	388	309	33
......	130	......	......	......	......	......	......	......	......	......	......	......	4	......	......	......	......	......	......	195	......	34
130	6,142	8	22	43	156	93	15	15	91	4	4	186	22	......	......	......	......	2	7	5,539	681	35
......	454	1	1	1	8	8	1	1	8	......	......	......	1	......	......	......	......	......	......	45	528	36
133	4,571	7	18	16	140	102	13	14	223	6	28	2,208	39	......	......	......	......	2	1	6,020	3,270	37
46	718	3	4	2	44	30	......	......	......	2	11	30	2	......	......	......	......	......	......	474	1,370	38
......	160	1	2	......	10	4	1	1	8	......	......	......	1	......	......	......	......	......	......	50	369	39
......	91	......	......	......	......	......	......	......	......	......	......	......	3	......	......	......	......	......	......	96	36	40
25	995	......	3	1	20	20	2	2	18	1	1	50	1	......	......	......	......	......	......	554	75	41
2	1,320	4	7	2	36	25	5	5	32	......	......	......	3	......	......	......	......	......	......	646	1,014	42
......	108	......	1	1	3	2	......	......	......	......	......	......	......	......	......	......	......	......	......	230	......	43
......	264	......	3	5	9	6	1	1	3	......	......	......	8	......	......	2	1	......	......	511	114	44
23	1,708	1	4	7	26	20	3	3	37	2	3	60	5	......	......	......	......	......	......	499	1,271	45
53	1,275	1	3	9	18	14	3	4	20	1	5	100	4	......	......	......	......	......	......	253	938	46
......	462	......	......	1	......	......	......	......	......	......	......	......	4	......	......	......	......	......	......	230	30	47
72	3,135	5	13	17	62	48	10	11	53	1	1	50	11	......	......	1	1	2	2	1,884	1,280	48
......	39	......	......	......	......	......	......	......	......	......	......	......	2	......	......	......	......	......	......	75	......	49

As might be expected, the 764 systems, while distributed through 48 states and territories, are to be found chiefly in the older and more densely populated sections. Massachusetts has the largest number, namely 106; New York is second, with 70 (or 71 if New York city were to be credited with two systems instead of being counted as one); New Jersey is third, with 57; followed by Pennsylvania, with 56; Ohio, 50; Michigan, 40; Indiana, 37; Illinois, 34; California, 28; Connecticut and Wisconsin, each 26; Maine, 22; Iowa, 19; New Hampshire, 18; Minnesota, 17; Colorado and Kentucky, each 12; Vermont, 11; and Texas, 10. New York, however, leads in almost every respect, having 5,578 signaling boxes, as compared with the next state in rank, Massachusetts, which has 4,890. With regard to the use of the telephone as central station equipment, Maryland is reported as having 1,920 drops, or lines, or a shade less than 30 per cent of the total capacity of the country thus engaged, while Pennsylvania has 2,208, or 34 per cent. In telephonic capacity 64 per cent of the total is thus accounted for, but as this represents only 7 switchboards, 1 in Maryland and 6 in Pennsylvania, it can not be accepted as a full indication of the facts, 55 of the boards being in use for such work in 21 of the other states or territories.

The total number of signaling and annunciating boxes in the United States was 37,832, from which 85,070 alarms were received. Of these alarms 12,794 are credited to New York, from 5,594 boxes, or 2 per box, per annum, whereas in the state of Illinois, with 2,278 boxes, the number of alarms received was 9,027, or 4 per box. In Massachusetts, with 4,890 boxes, 9,491 alarms were received, or 2 per box. In the state of Pennsylvania, with 3,566 boxes, 4,571 alarms were reported as having been received, or about 1.3 per box. In Kentucky, with 603 boxes, 1,864 alarms were reported, or 3 per box. In Minnesota, with 838 boxes, 2,430 fire alarms were reported, or 3 per box. The variations in the average number of fire alarms per box may be due either to the prevalence of wooden construction in buildings, resulting in more frequent fire alarms, or to the heavy duties thrown on the boxes by distributing them more sparsely. This latter supposition, however, does not appear to be borne out upon examining the distribution of boxes per mile of wire. For example, Illinois, with a total of 2,820 miles of wire, had 2,278 boxes, or less than 1 box per mile of wire, while Pennsylvania, with 7,591 miles of wire, had only 3,566 boxes, or less than 1 box to 2 miles of wire. Minnesota had 838 boxes to 1,084 miles of wire, or about the same proportion as Massachusetts, with 5,330 miles of wire and 4,890 boxes. New York appears to be well equipped in this respect, having 5,594 boxes to 4,937 miles of wire, thus giving more than 1 box to the mile. The higher proportion of boxes per mile of wire in New York may doubtless be explained by the liberal distribution in the densely populated districts of New York city and Brooklyn, but the difference between the figures for New York and Pennsylvania is, to say the least, quite striking. The proportion of alarms per box would indicate that Pennsylvania is as well served with its fire boxes as New York is with its larger number, but that Illinois falls below the standard of these two great Eastern states.

The suggestion that the number of alarms per box may have some relation to the use of wood in construction is supported by statistics from the Southern states, where the use of brick and stone is less prevalent than in the North. Tennessee, with 267 boxes, reported 995 alarms, or nearly 4 per box; Georgia, 412 boxes and 1,191 alarms, or nearly 3 per box; Virginia, 407 boxes and 1,708 alarms, or over 4 per box. In New York, and other closely settled cities in the Northern states, the use of wood for walls and roofs has long been prohibited within the urban areas, and the general introduction of structural steel in buildings has been a notable feature of the last decade.

Table 8 is of interest as presenting the figures for the electric fire alarm and police patrol systems of Honolulu, Hawaii.

TABLE 8.—*Electric fire alarm and police patrol systems of Honolulu, Hawaii: 1902.*

Date of establishment	1901
Overhead construction:	
Miles of pole line, owned	50
Total wire mileage, single wire	100
Number and character of boxes or signaling stations:	
Signaling, on poles or posts	50
Telephoning, on poles or posts	50
Special telephones	5
Fire alarms received	50
Police calls received or sent	2,750
Telephone	150
All other	2,600
Central office equipment:	
Automatic transmitters	4
Receiving registers, all kinds	1
Receiving circuits	4
Transmitting circuits	4
Telephone switchboards, number	1
Number of sections	1
Total capacity	150
Central station power equipment:	
Storage battery cells	290

The construction shown in this table was used interchangeably for fire alarm and police patrol purposes. All the construction is overhead, embracing 50 miles of pole line owned by the department, with 100 miles of circuit, and 50 signaling and 50 telephone boxes on poles or posts, supplemented by 5 special telephones. The central office equipment includes 4 automatic transmitters and 1 receiving register, 4 receiving and 4 transmitting circuits, and 1 telephone switchboard with a capacity of 150 drops, and the power equipment embraces 290 storage battery cells for supplying current to the whole system. During the year ending December 31, 1902, 50 fire alarms were received, averaging 1 per signaling box, and 2,750 police calls were received

or sent, of which 150 were telephonic. It is of interest to note that one of our outlying dependencies should be so well equipped, boasting of facilities which, in fact, a great many communities of importance within continental United States do not enjoy. The apparatus and methods, and probably the supplies, in use in Honolulu are, however, of American origin.

In a great many cities of the United States it is the custom of the municipal authorities to exact, by ordinance, by grant of franchise, or otherwise, the right to string wires on a certain number of cross-arm pins on the pole line of a telegraph, telephone, electric light, street railway, or other electric company, or to reserve the right to use a certain number of ducts in an underground wiring system belonging to a specific conduit company, or to any company operating some specified public service.

Table 9 gives the number of fire alarm and police patrol systems, grouped according to the population of the respective cities, which have reserved the right of way on poles or in conduits without cost to the city.

TABLE 9.—*Electric fire alarm and police patrol systems having perpetual right of way on poles or in conduits, without cost to the city, grouped according to population of cities: 1902.*

POPULATION GROUPS.	Fire alarm.	Police patrol.
Total	623	123
100,000 and over	34	30
50,000 and under 100,000	36	26
25,000 and under 50,000	73	31
10,000 and under 25,000	195	26
Under 10,000	285	10

According to Table 9, perpetual rights of way of this character have been reserved for 623 fire alarm and 123 police patrol systems. It is interesting to note that of the fire alarm systems, which secured rights and accommodations of this character without cost as an offset to the grants made to private companies, 480 belonged to communities of less than 25,000 population.

Table 10 may be regarded as a connecting link between the fire alarm and police patrol statistics embraced in this report, as it includes the systems, or portions of systems, which are employed interchangeably for fire alarm and police patrol purposes, grouped according to the population of cities. The statistics given in this table are included in the tables giving the data for fire alarm and police patrol systems, respectively.

TABLE 10.—*Construction and equipment of electric systems used interchangeably for fire alarm and police patrol, grouped according to population of cities: 1902.*

	Total.	POPULATION GROUPS.				
		100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Number of systems	23	6	4	5	2	6
Overhead construction:						
Miles of pole line—						
Owned	454	385	23	37	......	9
Leased	485	140	153	87	23	82
Wire mileage—						
Total	5,533	4,809	470	132	23	99
Single wire	5,488	4,770	465	131	23	99
Single wire in cables	45	39	5	1	......	......
Underground construction:						
Street miles of conduit—						
Owned	99	97	2	......	......	......
Leased	157	156	1	......	......	......
Wire mileage—						
Total	5,742	5,737	5	......	......	......
Single wire	70	68	2	......	......	......
Single wire in cables	5,672	5,669	3	......	......	......
Signaling boxes or stations	1,711	1,107	270	79	72	183
Number on poles or posts	1,472	961	222	69	72	148
All other	239	146	48	10	......	35
Special telephones	369	296	65	6	......	2
Central office equipment:						
Manual transmitters	12	7	3	1	......	1
Automatic transmitters	12	5	3	2	......	2
Receiving registers, all kinds	57	28	12	14	......	3
Receiving circuits	197	146	25	21	......	5
Transmitting circuits	121	63	37	17	......	4
Telegraph switchboards, number	34	31	1	1	......	1
Number of sections	39	35	1	1	......	2
Total capacity	354	328	12	10	......	4
Telephone switchboards, number	11	8	2	1	......	......
Number of sections	17	9	6	2	......	......
Total capacity	761	640	113	8	......	......
Single circuits	6	......	......	......	2	4
Central station power equipment:						
Motor generators and dynamotors, number	10	2	7	1	......	......
Total horsepower	5	2	2	1	......	......
Battery cells—						
Primary	7,748	6,709	446	200	146	247
Storage	4,227	1,631	1,690	832	......	74

The table embraces 23 systems, with 5,533 miles of overhead wire and 5,742 miles of wire in conduit, upon which were distributed 1,711 signaling boxes or stations, of which 1,472 were on poles or posts; these boxes were supplemented by 369 special telephones. The central office equipment of these systems included 12 manual transmitters, 12 automatic transmitters, 57 receiving registers, 197 receiving circuits, and 121 transmitting circuits. There were also 34 telegraph switchboards, with a capacity of 354 circuits, and 11 telephone switchboards, with a total capacity of 761 drops, or lines. Among these systems there were 6 single circuits, all of which were in communities of less than 25,000 population. The power equipment of the central offices embraced 7,748 cells of primary battery, 4,227 cells of storage battery, and 10 motor generators and dynamotors, with a total capacity of 5 horsepower.

These 23 combination systems were widely distributed as to the population of cities, 6 systems being in cities of 100,000 and over, 4 in cities of 50,000 and under 100,000, 5 in cities of 25,000 and under 50,000, 2 in cities of 10,000 and under 25,000, and 6 in cities and towns of less than 10,000. Cities of 50,000 population and over reported all of the underground construction of these systems and the great bulk of the apparatus, although it should be noted that the 6 plants in cities of less than 10,000 population had more than 30 boxes per system. It might be expected that the combination of the fire alarm and police patrol systems would have found favor in the small communities for reasons of economy, but this table does not support such an inference.

HISTORICAL AND DESCRIPTIVE.

The electric telegraph was not utilized for fire alarm purposes until the beginning of the second half of the nineteenth century. Even to-day there are a great many communities in America which retain the inadequate method of notifying the community by ringing a bell in some high tower, or by blowing a steam whistle, the number of strokes or pauses indicating roughly the location of the fire. As late as 1865, New York city had a watchtower system, under which a watchman, on discovering a fire or receiving an alarm, sounded upon his bell the number of the district; this was repeated by watchtowers all over the city, and thus the whole community was warned. While such a method was effective in distributing information, it is obvious that there was abundant opportunity for delay and mistakes; moreover, while the alarm served as an immediate call to duty, it also notified a large number of people who had no immediate concern in the matter.

It was inevitable that the introduction of the electromagnetic telegraph by Prof. S. F. B. Morse should direct attention to the ease with which warning signals could be instantaneously transmitted from point to point. The first suggestion for the use of the telegraph for fire alarm purposes is said to have been made by Dr. W. F. Channing, of Boston, as early as 1839, when the telegraph itself was in a very crude and imperfect condition. Making a suggestion, however, is one thing, and constructing a practical device is quite another. The history of electricity is full of instances where possibilities were suggested years before it was found feasible to devise the proper apparatus. It is an authentic fact, however, that in 1845 Doctor Channing published in the Boston Advertiser an article in which he described a method of applying the telegraph to fire alarms. The plan was as follows:

A central office was to be established in some public building, in which the necessary battery, together with a Morse register and an alarm bell, should be located; a double wire to proceed from thence over the housetops successively to every engine house and fire bell in the city, and return again to complete its circuit to the place from whence it started. In every station thus established a Morse register in connection with an alarm bell was to be placed, also a key, by the simple depression of which an appropriate signal would be instantly conveyed to every other station on the circuit.

He also suggested the modification of having five or six circuits, or even a circuit from every station, to the central office. By this method the operator would be able to communicate directly to all the stations, and, if so desired, every alarm of fire might be made to pass through the central office before being communicated to the different stations. From among the many modifications to which his design is susceptible, Doctor Channing calls special attention to one, in these words: "There is, however, one which deserves to be specially mentioned. By a slight change of the arrangement of the alarm bell stations and increase of machinery, the hammers of the bells could all be disposed so as to strike mechanically on the communication of a galvanic impulse from the central office. The agent (operator) would therefore be enabled, by depressing a single key with his finger at certain intervals, to ring out an alarm defining the position of the fire simultaneously on every church bell in the city." This description clearly indicates the electro-mechanical bell striker, urges the municipal authorities to take his project into consideration; and, as the city had been behindhand in the matter of giving alarms of fire, the adoption of this system would place her in advance of other cities.[1]

Nothing, however, was done until early in the winter of 1847–48, when Mr. L. L. Sadler, superintendent of the Boston and New York telegraph line, in discussing with Mr. F. O. J. Smith, one of the pioneer capitalists associated with Morse, and then president of the Portland telegraph line, the feasibility of using telegraphy for fire alarm purposes, stated that he had in his employ at Framingham, Mass., an operator named Moses G. Farmer, who was the most ingenious man he had ever seen, and who, he believed, could work out a system. The matter was brought to young Farmer's notice, and within a week he had produced an apparatus capable of carrying out the idea, based on electro-magnets and the striking mechanism of an old church clock. This was the first machine ever constructed for giving an electric fire alarm, and served as the starting point for all the later work that has been done in this field. Nothing more came of it at the time, however, although the apparatus was indorsed by Mayor Quincy, of Boston.

In 1851 Doctor Channing succeeded in interesting the Boston city council in the subject of fire alarm telegraphs to such an extent that $10,000 was appropriated for an experiment. His plan again proposed numerous box stations, connected by telegraph circuits with the central office, from which all alarm signals received from the boxes were to be sent out over other circuits to the bell towers, so that the box signals would be simultaneously struck, electrically, by every fire alarm bell in the city. At a total cost of about $16,000 this system, with some modifications, was adopted for 39 signal stations.

It is possible that both Doctor Channing and Professor Farmer worked out their ideas independently, although attention should be called to the fact that Mr.

[1] Adam Bosch, Trans. Am. Inst. Elec. Engrs., Vol. XIV, 1897, page 336.

Charles Robertson, who introduced the Morse telegraph system into Germany, had utilized it in New York city in 1850 to aid the fire department in signaling the existence of fires. In fact, lacking evidence to the contrary, it would appear that the authorities in New York city were pioneers in this direction. As early as November, 1846, the common council of the city authorized the introduction of the Morse magnetic telegraph into the fire service, and in the next month at a meeting of engineers and firemen, a committee of five was appointed to urge the adoption of the plans recommended by the chief engineer relative to such work. In 1847 a permit was granted to Hugh Downing and Royal E. House, a well-known telegraph inventor, to set up a line of telegraph for fire purposes in different parts of the city, at a cost of $500. In 1851 the connection of the bell towers with fire headquarters by telegraph was completed with immediate beneficial results, but it is a matter of official record that public curiosity on the subject was so great that the entire telegraph apparatus was often put out of service by the tampering fingers of innocent visitors. Nothing permanent, however, came of such experimental work, and, for the evolution of the practical machinery required, attention must be paid to the joint efforts of Doctor Channing and Professor Farmer. In 1851 Professor Farmer became superintendent of the Boston fire alarm system, continuing in active service until 1855, and remaining for another four years with the department which his skill and ingenuity had done so much to create. During this period Doctor Channing and Professor Farmer took out, singly and together, several patents which became the foundation of the fire alarm system as it exists to-day. One of these patents, covering what was known as the "village system," was taken out by Professor Farmer in 1859.

It naturally would be supposed that so invaluable an aid in subduing fires would receive the warmest welcome from those engaged in fire extinction; but it is a fact that the bitterest enemies of the new system were found among the firemen themselves. The fire departments, about the middle of the last century, were volunteer organizations, often partaking of the character of a club, and frequently engaged deeply in politics. The introduction of prompt and efficient methods of giving the alarm marked the beginning of a new era and the creation of the paid fire alarm departments.

The advent in the field of the late Mr. John N. Gamewell marked another point of departure in the art and industry. In regard to his work, Mr. J. W. Stover has said:

> The fire alarm telegraph as it stands to-day is not the work of one nor a half dozen men. Many have contributed to its perfection. I have only named a few. It has been an evolution; but if I were asked to name the one man to whom, more than all others, we are indebted for its progress and general use, I should without hesitation name John N. Gamewell, of South Carolina. From 1855 to the time of his death he devoted his splendid business ability and his best efforts for its advancement and its extended use. It has been a number of times suggested to me that those who best understand the importance of his work should erect a monument to his memory. My answer has been, and is, It is not necessary; the evidence of his devotion and beneficent work may be found on nearly every street of nearly every city and town in this broad land. [1]

Hearing or reading a lecture by Doctor Channing on the subject of fire alarm telegraphs, delivered in the Smithsonian Institution at Washington in 1855, Mr. Gamewell at once became deeply interested in the subject, and bought from Messrs. Channing and Farmer the right to the use of their inventions and patents in the Southern states. In 1859 he purchased the rights for the rest of the country. This investment, while small compared with what is expended upon fire alarm telegraphs at the present time, was an evidence of great courage and enterprise in those days. The original plant in Boston, installed in 1852, comprised only 19 tower bell strikers and 26 street signal stations, and during the year 1854—two years after the system had been introduced—the number of fire alarms in Boston was only 195. The Boston system, with some improvements, was taken up in Philadelphia in 1855, and St. Louis closed a contract in 1856, though this plant was not in use until early in 1858. The cities of New Orleans and Baltimore adopted the system in 1860, but further development was seriously arrested by the outbreak of the Civil War.

No sooner was the war over than Mr. Gamewell again took up the work actively, pushing the system with great vigor and perseverance by means of a corporation to which he gave his name. But it was not until 1869 that New York city, which had organized a paid department in 1865, abandoned its old watchmen and bell towers in favor of the modern methods with which this report deals. Since that time the progress of the system has been rapid, and several ingenious inventors have devoted their energies to the subject. The leading systems are those known broadly as the Gamewell, the Gaynor, and the Speicher.[2]

The apparatus has of course been greatly improved since its introduction. For example, the first signal boxes used in Boston depended for their operation upon the turning by hand of a crank similar to the one so long a familiar feature of telephone stations for ringing up "central." The original instructions placed on these signal boxes were that the person sending in the alarm should turn the crank six times. Fastened directly to the shaft of this crank was the break-circuit wheel; one-half of this wheel was so toothed that in revolving it transmitted and recorded in dots or dashes, by means of a Morse register at the central fire headquarters, the number of the fire district in which the

[1] "Progress in Fire Alarm Telegraphy;" paper read before International Association of Fire Engineers, New York city, September, 1902.

[2] For details see Maver's "American Telegraphy and Encyclopedia of the Telegraph."

fire was located, while the other half transmitted a certain number of current pulsations, indicating on the Morse register the number of the box. The tower bell was still used, but only to sound the district: in order to ascertain the exact location of a fire, the firemen were supposed to go to the street boxes and count the taps or strokes made on the small bells inside, these signal taps being sent from the central office as soon as the alarm had been transmitted to the tower bells. If a fireman on reaching such a box did not find the bell striking, it was his duty to signal the central office at once, whereupon the operator there would repeat the signal, unless the circuit had been broken or interrupted. All this was excellent in theory, but it was quickly demonstrated that people sending in alarms would exercise the crank so vigorously, in the excitement of the moment, that the operator at the central office could not decipher the signals. The instructions upon the boxes were then made to read to the effect that the crank should be turned twenty-five times, which would seem to give abundant opportunity for sending in the signal clearly, but even then there were mistakes and delays. With regard to Boston, Mr. Adam Bosch says:

> The original crank signal boxes remained in service in Boston until 1866, in which year automatic boxes were substituted in their place. The following year, Joseph B. Stearns, the immediate successor of Farmer in the superintendency of the Boston fire alarm telegraph, received a patent for an apparatus operated by "reverse currents," which permitted the simultaneous use of the same wire for receiving a signal from a box and transmitting it to the alarm bells. Several years prior to the introduction of automatic signal boxes, Stearns abandoned the method of striking the district numbers on the bells, and new boxes were designed to strike the box numbers only. While, with the adoption of the automatic signal box, the speed with which a fire alarm box was operated no longer depended on the temperament or mental condition of the person giving the signal, a proof was soon furnished that in a matter of this kind as little as possible should be left to "the intelligence of the public." Incorrect signals were often received from these boxes, for the occurrence of which no cause could be assigned. It was usually the first "round" that was found to be wrong. This remained a puzzle until the cause was discovered, which was this—that the person giving the alarm, disregarding the instructions to "pull the hook down once and let go," would, after the first pull, by way of emphasis, give the hook another pull or two. This would momentarily suspend the movement of the break wheel, and if it occurred between two successive breaks a long pause would ensue, and the signal would be either unintelligible or a number entirely different from the box number would be transmitted.

One of the first important steps forward, therefore, was found in the automatic signal box, operated by pulling the hook trigger and then releasing the mechanism. The patent on this device was taken out in 1867 by Mr. Charles T. Chester, of New York, while further improvements were made and patented about two years later by Crane and Rogers, of Boston, who introduced what was called the "noninterference pull." The use of this prevented interference with a signal sent in by a box until its completion; hence each box was enabled to transmit its signal free from the mistakes and delays caused either by careless and excited persons or by those governed by malicious intent.

In 1871 Mr. Gamewell, who was the first to use an open-circuit break wheel, secured the first patent on his noninterfering signal box; this prevented interference or confusion between alarms sent in from different boxes at the same time, thus securing certainty of transmission. The new Gamewell box was a normally wound box with trigger pulls and a so-called skeleton break wheel. All automatic boxes were actuated either by weights or by springs; if the latter, they were pull wound. The Gamewell box contained an electromagnet and an armature which, when in the position farthest from the magnet, shunted the break wheel. If a box was pulled while the armature was in its normal position against the magnet, the armature was held there until the signal was completed. By the same mechanism the armature in every other box on the same circuit was held in position to shunt the break wheel, so that, even if another box were pulled, interference with the first signal would be impossible. The only chance of interference lay in the possibility that the hook of the second box might be pulled the instant the circuit was closed, and while the armature was still held close to the magnet; but the use of a skeleton break wheel made these periods of contact so exceedingly short that the chances of interference were very remote.

The next step forward in this important direction was taken by Mr. J. M. Gardner, of Hackensack, N. J., who in 1880 patented a box[1] which provided not only against the dispatch and reception of confused alarms due to the use of imperfect pull devices at the signal box, but also against interference with a signal from any box through the "cutting in" of another box on the same circuit; in this way both "local" and "distance" noninterference were secured. The benefits of this improvement were felt in the more rapid detection and extinction of fires.

Another important improvement in signal boxes was introduced by Mr. Tooker, of Chicago, in 1875. Hitherto delays had often occurred in transmitting alarms because the key to open a box could not be found on the instant. The Tooker keyless door was intended to deter malicious persons from sending in false alarms or otherwise interfering with the apparatus. The door was opened by the turning of a handle, which wound up a spring, thus setting in motion the mechanism by which a local alarm was sounded on a small gong within the box. The person using the Tooker device, having turned the handle of the door and heard the local alarm, often thought he had done all that was necessary, and would walk away without pulling the hook that sent in the signal to "central," so that the vital part of the signal was omitted. The next step in the development of this idea was the invention made by Mr. M. H. Suren in

[1] See "Maver's American Telegraphy and Encyclopedia of the Telegraph" for technical details.

1895. In the operation of this invention it was only necessary that the handle of the door should be turned, whereupon the bell rang and the alarm was transmitted to the central office without even opening the door of the box. A similar development is seen in the device patented by Mr. J. J. Ruddick in 1889, by means of which the boxes, besides being noninterfering, are made to succeed each other, each in turn sending in its own definite signal, even if three or four boxes on the same circuit are pulled at the same time.

It is a common practice to call attention to the signal boxes and poles by painting them a bright red color, or in some other way equally distinctive, so as to enable a person desiring to use a box to find it immediately. In many communities lists of signal boxes are printed and distributed, so as to familiarize the public with their location.

Reference has already been made to the fact that as early as 1859 Professor Farmer took out a patent on the "village system." A crude system of this kind was installed in Mobile, Ala., in 1866. It is obvious, however, that in view of the cost of maintaining a staff solely for the fire alarm service, towns and villages of small size could not enjoy this means of protection unless the human element had in a large measure been eliminated. In 1870 the village system was rendered feasible of application by Mr. Edwin Rogers, of Boston, who patented what is known as the "automatic repeater." This device made it practicable to strike all the bells and gongs of a fire alarm system directly from one street signal box without the intervention of an operator at the central office. The idea was too valuable, however, to remain restricted in its application to only small cities, and the principle was rendered useful in central office systems by the application of what is known as the "joker," invented in 1876 by Prof. J. P. Barrett, superintendent of the bureau of electricity of the city of Chicago, and head of the electrical department of the Columbian World's Fair in 1893. By means of the "joker" alarms can be sent directly from a signal box to the fire companies whose duty it is to respond first. This, in combination with the automatic repeater, has been found invaluable in modern work.

In the fire engine house, to which signals from central are transmitted, is usually found the electro-mechanical indicator, which dates back to 1875. This is placed in a conspicuous position, and shows at once, in large figures, the number of every box from which an alarm is being transmitted; in this manner each alarm is brought to notice, and the location of the fire indicated. The gongs in engine houses, rung by the direct agency of electro-magnets which attract and then release an armature, are another familiar feature; many of them are from 6 to 24 inches in diameter. Other important accessories in such work are the whistle, which is often sounded in small communities, and particularly the tower bell, which remains a distinct element of fire alarm work. In some instances these bells have reached remarkable proportions, one type striking 10,000 blows of a most sonorous character, with a weight drop of 25 feet. An ingenious feature in connection with this bell is its attachment to an electric motor which automatically starts to rewind the mechanism when the weight has run down; and this automatic winding system can be used also to wind up the weights driving the transmitters and multiple registers at the central fire headquarters.

The switchboards are, of course, the most conspicuous feature of the central fire office; they are usually handsome and substantially built of mahogany or walnut in the form of a hollow square, so that the operators have all the apparatus and mechanism within easy reach. In the fire alarm circuits are inserted galvanometers, whose readings can be taken at the board, to show that the batteries are up to the electro-motive force required for signal transmission, and also to indicate the electrical condition of the circuits themselves, giving notice of any break or grounding. In fact, the circuits are under constant test, as it is obvious that nontransmission of a signal might be attended with disastrous and even fatal results. The central office apparatus includes a relay in each circuit from the signal boxes; for each relay there is a multiple pen or registering device for the purpose of permanently recording the alarms received, and an annunciator so placed that the opening of the circuit causes the electro-magnetic drop to fall, disclosing the number of the circuit affected.

A notable feature of every well organized central fire alarm telegraph office is the repeater, under a glass case in the center of the operating room. This repeater is usually provided with a locking mechanism, by means of which all the armatures of the relays of fire signal box circuits, except that on which the alarm has come in, are locked, so that they can not respond to any new alarm that may be sent in during the transmission of the first alarm; thus confused signals are avoided. There are other devices also employed as adjuncts of this work, such as voltmeters, ammeters, and other apparatus for electrical measurements, etc.

The battery itself was at first of the expensive Grove and Daniells type, but for a great many years past it has been of the type of primary cell known as the gravity, or sulphate of copper—a form quite suitable for fire alarm telegraph requirements, being easily supplied with new material, readily cleaned, and simple enough in construction to be maintained by any fireman of ordinary intelligence.

Within the last decade, however, the storage battery has been adopted for this class of work to a considerable extent, being found in many of the larger cities. The maintenance cost of the storage battery equipment is said to be only half that of a primary battery plant of equal size; but since the battery equipment is hardly large enough, as a general thing, to warrant the expense

of an independent or isolated power plant, the practice is generally to connect the batteries with the local central power station, from which the needed supply of charging current is ordinarily obtained. It is obvious, however, that even this source of supply can not always be depended upon, although the batteries carry a considerable reserve supply; hence some of the central fire alarm stations maintain more than one source of current supply, or connect with a source by more than one circuit.

A further development of recent years has been the more general use of the telephone for fire alarm service. This arose in a natural and simple manner from the fact that telephone subscribers in many small towns would call "central" to ask where the fire was. It was readily seen that "central" could be employed very usefully, either as an auxiliary in the transmission of fire alarms or as a fairly efficient substitute for the regular alarm. For example, at Kansas City, Mo., the local telephone service discharges all the functions of a fire alarm system; the police patrol system there has, however, a signal telegraph.

Another very interesting feature of the more recent developments, which, however, is not considered in the statistical portion of this report because it does not constitute an integral part of the municipal fire alarm telegraph, is what is known as the auxiliary system. The auxiliary boxes are placed in convenient locations in buildings, in a school, for example, at the teacher's desk; in case of fire, a small glass pane in the front of the box is broken, and a ring pulled down, which action operates a trip in the nearest street box and causes the alarm to be sent to fire headquarters exactly as though the box had been pulled by hand. The auxiliary circuit has a special battery, and is not connected electrically with the regular circuits of the fire alarm system.

As a general thing the municipal fire alarm systems, like telephone companies, have resisted the attachment of any auxiliary apparatus to the devices with which communication is maintained, on the ground that needless additional complication was brought about, thus lowering the efficiency of the system. The auxiliary fire alarm telegraph, however, is so valuable an aid to the fire department that its use has been encouraged. By the use of this system, not only can an alarm be transmitted at once to the fire department, no matter how remote the nearest street box may be, but persons all over the building can be notified immediately and the chance of panic is thus minimized. In New York city, at the beginning of 1902, no fewer than 2,400 of these boxes had been installed, with the approval of the New York Board of Fire Underwriters. The only serious objection to such work has been the leaving of the auxiliary devices in the hands of a private or individual commercial company, instead of constituting it part of the municipal department under control of the city authorities.

Another kind of fire alarm telegraph, somewhat automatic in character, is that known as "thermostatic." In this the materials or mechanism of the thermostats, when heated to a given degree of temperature, close the circuit, thus sending in an alarm, and in some cases also releasing showers of water from pipes so placed that a fire may be put out, even before outside assistance arrives. Of course, there is always the chance that such a device may go off accidentally, through some rise of temperature not due to an outbreak of a fire, or through some accident to the mechanism, in which event, if water is released, considerable damage may be done to perishable goods. A quite ingenious extension of the thermostatic principle has been made in the use of a cable in which a soft metal fuse wire is interwoven with the copper wires which constitute the alarm circuits; the generation of undue heat melts immediately the fuse wire in the cable, thus closing the circuit and sending in an alarm. This is a portable and variable arrangement, which can be modified to meet changing circumstances, as, within a storage warehouse or a large department store, the cable may be trailed or drawn at will over any pile of goods to any point where a fire might possibly break out. In Boston some 500 buildings are equipped with automatic fire alarms, and no fewer than 110 with the sprinkler equipment.

Another important part of fire protection work in the leading cities, which should be noted in this connection, is the insurance patrols, maintained by the fire insurance companies themselves. This work consists chiefly in spreading rubber covers over valuable goods at the moment when the risk of loss of such perishable materials is greatest. Perhaps one of the best examples of this is the Boston protective department, maintained by the insurance companies doing business in that city. It has a staff of no fewer than sixty men, specially trained for the work of protecting property exposed to fire and water damage. They operate with six special wagons, supplied with rubber covers, duplicate sprinkler heads, gas fittings, extinguishers, and emergency tools of various kinds, and are in constant readiness to respond to an alarm of fire, just as is the regular fire engine or hose reel. The staff and the wagons are concentrated at three houses, located in sections of the city where the greatest values of property are massed.

Fire alarm pole lines are usually constructed with more than ordinary care, although the wires are sometimes strung upon the poles of the local electric light, telegraph, and telephone companies, and even on those of the trolley systems. Metallic circuits are always used; that is, there is a complete circuit by wire from the box to central and from central back to the box, and also between all other points of communication, the earth being used as part of the circuit only in case of an accident. It is considered good practice to secure the wires to poles at a height of not less than 20 feet from the ground, and to use the finest quality of galvanized-iron wire or hard-drawn copper wire; the wire

generally employed has a weight of about 325 pounds to the mile for iron and 170 pounds for copper. All the joints are carefully soldered, and the terminal connections of both iron and copper wires are made with insulated copper wire run through the buildings and up to the apparatus, conduits being often employed for this interior work.

When underground cables are used for fire alarm purposes the ends of the cables are brought out at short intervals to small switchboards usually placed on lampposts, following the method proposed by Mr. William Maver, jr., at one time expert on the electrical subways in New York city. In this manner easy access is afforded to the circuits for testing purposes.

In view of the vitally important nature of fire alarm telegraphs, it is rather surprising that more work has not been done in placing the wires underground—not merely out of the way, but where they would be less exposed to the elements or the risk of malicious breakage; no winter goes by and no high wind passes without the breaking of some aerial telegraph circuits.

A scheme for the use of wireless telegraphy in fire alarm signaling apparatus has been suggested by Signor Mollo, chief of the fire department of Naples, Italy, and others. M. Emile Guarini has worked out a plan for the equipment of fire engine houses and numerous buildings at Brussels, Belgium, but at the time of this report it is not known whether the system has been put in operation.

The idea is to utilize thermostats for alarm purposes. The rising of a column of mercury, closing the circuit, energizes an electro-magnet, which, in turn, attracts an armature and releases a disk revolving by means of a spring motor. Each disk has notches cut on its periphery at such distances that they represent arbitrarily, in a code, the number and location of the building. When the disk revolves, its periphery projections make and break a primary circuit, setting up alternating current in the secondary coil, which, in turn, energizes an oscillator system, sending out into space the waves which represent the message. These waves are received upon a long aerial wire raised vertically at the fire engine house and are again converted into oscillations in the resonator circuit, so that the coherer is affected in the usual way, the filings in the coherer being made to close the circuit as the waves come in, and being decohered by the tapper in the relay circuit; the message thus received is recorded on the tape of the register for the local circuit. This system embodies some of the important features of the village and automatic systems already described. At the same time, as a wireless system can not detect the source of a signal, serious difficulties would appear to stand in the way, and the opportunities for malicious interference might be greatly increased, unless some means could be devised to protect the receiving apparatus at the engine house against receiving wireless signals originating elsewhere than at the scene of a fire.

ELECTRIC POLICE PATROL SYSTEMS.

Reports were received from 148 electric police patrol systems. The data for systems used interchangeably for the fire alarm and police patrol services have already been referred to in connection with the statistics for fire alarm systems. The service is of much more recent date than that of the fire alarm, and does not, therefore, include so many plants.

Table 11 shows the boards or departments of administration to which the several police patrol systems are subject.

TABLE 11.—*Electric police patrol systems, grouped according to boards or departments of administration: 1902.*

BOARDS OR DEPARTMENTS OF ADMINISTRATION.	Systems.
Total	148
Administrative bodies	49
Board of police commissioners (or commissioner)	27
Board of police and fire commissioners	6
Board of public safety (or director, or commissioner of)	14
Board of public works (or commissioner of)	4
Board of trustees	1
Department of electricity (or city electrician)	7
Department of fire and police patrol telegraphs	2
Department of police and city property	1
Department of wire inspection	1
Fire commissioner and city council	1
Mayor	1
Mayor and board of police commissioners	1
Mayor and chief of police	1
Mayor and city council	3
Mayor and city marshal	1
Police department (or police)	24
Special committee by vote of town	1
Superintendent of police and board of public safety	1
Not reported	2

From this table it will be seen that 49 systems, or about one-third of the total number reported in 1902, were governed by administrative bodies—boards of aldermen, boards of selectmen, city councils, etc.—27 by boards of police commissioners, 24 by police departments, and 14 by boards of public safety.

As already noted, electric fire alarm systems were installed and operated as early as 1852, and during the decade from 1862 to 1872 no fewer than 40 systems were put into operation. However, with regard to police patrol systems, work in this field was of a very uncertain and indifferent character up to the year 1881.

The following table shows the number of police patrol systems installed during each year from 1867 to 1902, inclusive:

TABLE 12.—*Electric police patrol systems installed each year.*

YEAR.	Number.	YEAR.	Number.
Total	148	1885	3
		1884	6
1902	8	1883	3
1901	6	1882	1
1900	8	1881	1
1899	7	1880	1
1898	8	1879	1
1897	5	1878	1
1896	8	1877	
1895	7	1876	1
1894	9	1875	
1893	11	1874	1
1892	7	1873	
1891	10	1872	
1890	13	1871	
1889	4	1870	1
1888	3	1869	
1887	6	1868	
1886	7	1867	1

It will be seen from the above table that only 8 systems had been installed prior to 1882. From that year onward, however, a marked increase was seen. The decade 1882 to 1892 witnessed the installation of 56 plants; the decade 1892 to 1902 was even more active, 76 plants being installed during the period, while during the eleven years from 1892 to 1902, inclusive, there were in all 84 installations. It will be observed, however, that the increase in the introduction of electric police patrol systems has hardly kept pace with the adoption of fire alarm systems, the number of fire alarm systems being in 1902 more than five times as great as the number of police patrol systems, in spite of the fact that the two can be and are so frequently operated in cooperation, or under the same management.

The following table presents the general statistics with regard to the construction and equipment of the service and the amount of work done, together with the percentage which each item is of the total:

TABLE 13.—ELECTRIC POLICE PATROL SYSTEMS, GROUPED ACCORDING TO POPULATION OF CITIES, AND PERCENTAGE EACH ITEM IS OF TOTAL: 1902.

	POPULATION GROUPS.						PER CENT OF TOTAL.				
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Number of systems	148	34	30	39	33	12	23.0	20.3	26.3	22.3	8.1
Overhead construction:											
Miles of pole line—											
Owned	829	582	101	95	42	9	70.2	12.2	11.4	5.1	1.1
Leased	3,187	1,589	537	613	302	146	49.9	16.8	19.2	9.5	4.6
Wire mileage—											
Total	17,339	13,552	1,828	1,197	578	184	78.2	10.5	6.9	3.3	1.1
Single wire	14,296	10,654	1,767	1,149	542	184	74.5	12.4	8.0	3.8	1.3
Single wire in cables	3,043	2,898	61	48	36	....	95.2	2.0	1.6	1.2	....
Underground construction:											
Street miles of conduit—											
Owned	271	239	19	1	12	....	88.2	7.0	0.4	4.4	....
Leased	502	425	31	18	28	....	84.6	6.2	3.6	5.6	....
Wire mileage—											
Total	9,011	8,646	178	69	118	....	95.9	2.0	0.8	1.3	....
Single wire	264	172	58	6	28	....	65.1	22.0	2.3	10.6	....
Single wire in cables	8,747	8,474	120	63	90	....	96.9	1.4	0.7	1.0	....
Number and character of boxes or signaling stations:											
Signaling	9,476	6,496	1,330	873	497	280	68.6	14.0	9.2	5.2	3.0
Number on poles or posts	6,747	4,217	1,127	772	399	232	62.5	16.7	11.5	5.9	3.4
All other	2,729	2,279	203	101	98	48	83.5	7.4	3.7	3.6	1.8
Telephoning	1,170	798	95	115	154	8	68.2	8.1	9.8	13.2	0.7
Number on poles or posts	1,060	753	94	78	128	7	71.0	8.9	7.3	12.1	0.7
All other	110	45	1	37	26	1	40.9	0.9	33.7	23.6	0.9
Special telephones	1,998	1,668	197	112	17	4	83.5	9.9	5.6	0.8	0.2
Police calls received or sent	40,626,505	31,558,693	5,150,225	2,301,511	1,252,408	363,668	77.7	12.7	5.6	3.1	0.9
Telephone	23,393,812	20,430,896	1,439,191	404,791	925,731	193,203	87.3	6.2	1.7	4.0	0.8
All other	17,232,693	11,127,797	3,711,034	1,896,720	326,677	170,465	64.6	21.5	11.0	1.9	1.0
Central office equipment:											
Manual transmitters	83	40	14	19	8	2	48.2	16.9	22.9	9.6	2.4
Automatic transmitters	30	10	7	9	2	2	33.3	23.3	30.0	6.7	6.7
Receiving registers, all kinds	439	311	51	49	21	7	70.8	11.6	11.2	4.8	1.6
Receiving circuits	1,272	826	138	195	90	23	64.9	10.9	15.3	7.1	1.8
Transmitting circuits	983	577	138	166	88	14	58.7	14.0	16.9	9.0	1.4
Telegraph switchboards, number	70	42	12	10	4	2	60.0	17.1	14.3	5.7	2.9
Number of sections	84	49	12	11	9	3	58.3	14.3	13.1	10.7	3.6
Total capacity	578	433	64	59	14	8	74.9	11.1	10.2	2.4	1.4
Telephone switchboards, number	187	142	13	20	11	1	75.9	7.0	10.7	5.9	0.5
Number of sections	224	158	17	33	15	1	70.5	7.6	14.7	6.7	0.5
Total capacity	3,055	2,370	195	201	286	3	77.6	6.4	6.6	9.3	0.1
Single circuits	28	3	3	5	11	6	10.7	10.7	17.9	39.3	21.4
Central station power equipment:											
Motor generators and dynamotors—											
Number	18	8	7	2	1	....	44.4	38.9	11.1	5.6	....
Horsepower	18	8	2	7	1	....	44.4	11.1	38.9	5.6	....
Battery cells—											
Primary	24,477	19,785	1,907	1,178	1,147	460	80.8	7.8	4.8	4.7	1.9
Storage	11,317	4,823	3,439	2,239	742	74	42.6	30.4	19.8	6.6	0.6

The 148 systems reported were distributed as follows: 34 in cities of 100,000 population and over, 30 in cities of 50,000 and under 100,000, 39 in cities of 25,000 and under 50,000, 33 in cities of 10,000 and under 25,000, and 12 in cities and towns of less than 10,000. These 148 plants had a total overhead wire mileage of 17,339 miles, comprising 14,296 miles of single wire and 3,043 miles of single wire in cables, and occupying 3,187 miles of leased pole line and 829 miles of pole line owned by the respective departments. In addition to the overhead construction there were 9,011 miles of wire in underground construction, of which 264 miles were single wire and 8,747 miles single wire in cables. This wire and cable occupied 502 miles of leased conduit and 271 miles of conduit owned by the departments. The circuits thus enumerated were occupied by 9,476 signaling boxes, of which 6,747 were on poles or posts and 2,729 otherwise disposed. There were also 1,170 telephone boxes, of which 1,060 were on poles or posts, leaving 110 in booths, buildings, etc. The number of special telephones used by the departments was 1,998. Over all these instruments 40,626,505 police calls were received or sent, of which 23,393,812 were telephonic and 17,232,693 were of signaling and all other kinds.

The central office equipment of these 148 systems comprised 83 manual transmitters; 30 automatic transmitters; 439 receiving registers; 1,272 receiving circuits; 983 transmitting circuits; 70 telegraph switchboards, with a total capacity of 578 lines; 187 telephone switchboards in 224 sections, with a total capacity of 3,055 drops or circuits; and 28 single circuits, the nature of which has been previously explained in connection with Table 3 of fire alarm sys-

tems. The central station power equipment for the operation of this apparatus included 24,477 cells of primary battery, 11,317 cells of storage battery, and 18 motor generators and dynamotors, with a total capacity of 18 horsepower. As in the case of the fire alarm service, the underground construction is practically confined to the larger cities, none of it being found in cities of less than 10,000 population, and only 365 miles out of a total of 9,011 miles of circuit, in cities of less than 100,000 population. The bulk of the signaling apparatus, as of the circuits, whether overhead or underground, is also concentrated in the larger cities, 6,496 signaling boxes, or 68.6 per cent of the total number, being found in cities of a population of 100,000 and over, while of the telephone boxes 798, or 68.2 per cent, were found in cities of the same population group. The work done by the service followed practically the same proportions, 77.7 per cent of the total calls received or sent being limited to the cities in the highest population group. The 10,646 signaling and telephoning boxes reported were distributed over 26,350 miles of circuit, or 1 box to every 2½ miles of circuit. For these 10,646 boxes, the total number of messages sent and received was 40,626,505, giving an average, per box or station, of 3,816 messages during the year, or a daily average use of more than 10 calls. This would appear to be a very extensive use of the systems, and will give some idea of their value and service as a means of increasing the efficiency of the police department and of furnishing aid at times of emergency. It is noticeable that the use of the telephone predominated, the number of telephonic messages being 23,393,812, as compared with 17,232,693 of all other kinds. The difference between the fire alarm and police patrol systems is here sharply indicated. In the case of the former, when a fire breaks out, the chief object is to notify headquarters and near-by engine houses, etc., of the exact location of the fire, which can best be done by having each box preadjusted to transmit a definite signal. On the contrary, in police administration, the occasions which arise for the use of the telephone, aside from locating an officer on his beat, are of a most varied character, requiring, both in transmitting messages to headquarters and in receiving them upon a beat, the giving of a number of specific details, which could not be conveyed by prearranged signals. The inference with regard to the telephonic service is not correct, however, if based upon the number of telephoning boxes only, as it would appear that the 1,998 special telephones should be considered. If, therefore, the number of special telephones be added to the number of telephoning boxes or stations, it would appear that the 3,168 telephones are to be credited each with 7,384 calls sent or received, or about four times as many as the signaling boxes, a striking demonstration of the prominent part played by the telephone in the police patrol system.

The variations in the service are further illustrated by a study of the percentages shown in Table 13. The systems were well distributed, 23 per cent being in cities of 100,000 population and over, 20.3 per cent in cities of 50,000 and under 100,000, 26.3 per cent in cities of 25,000 and under 50,000, 22.3 per cent in cities of 10,000 and under 25,000, and 8.1 per cent in cities and towns of less than 10,000. The table brings out very clearly the fact that cities of 100,000 population and over reported a large proportion of the equipment; and that, extensive as the use of the police signal box and telephone has been shown to be, they are still limited to the larger cities; 68.6 per cent and 68.2 per cent, respectively, of the total number of such boxes were located in cities of 100,000 population and over, while the corresponding percentages for cities in the smallest population group are 3 and 0.7, respectively. Moreover, cities of 100,000 population and over received and sent 77.7 per cent of all police calls, and no less than 87.3 per cent of all telephone messages. Thus there appears to be a large field for the introduction of telephones for police service in the smaller communities, where they would be most useful, the number of officers being few and the population and dwellings being sparsely scattered over a large area.

Table 14 may be studied in conjunction with Table 13, as showing the number of police patrol systems reporting the different items of construction and equipment, grouped according to the population of cities.

TABLE 14.—*Electric police patrol systems reporting different varieties of construction and equipment, grouped according to population of cities: 1902.*

CHARACTER OF CONSTRUCTION AND EQUIPMENT.	NUMBER OF SYSTEMS, BY POPULATION GROUPS.					
	Total.	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Overhead construction:						
Pole line—						
Owned exclusively	14	4	2	4	3	1
Leased exclusively	105	20	19	30	26	10
Owned and leased	29	10	9	5	4	1
Overhead construction exclusively	91	6	19	29	25	12
Underground construction:						
Conduit—						
Owned exclusively	13	5	5	1	2	......
Leased exclusively	35	14	6	9	6	......
Owned and leased	9	9	......	......	......	......
Both overhead and underground construction	57	28	11	10	8	......
Boxes or signaling stations:[1]						
Signaling boxes exclusively	125	28	28	34	24	11
Telephone boxes exclusively	19	4	2	4	8	1
Both signaling and telephone boxes	3	1	......	1	1	......
Special telephones	56	22	11	16	5	2
Central office equipment:						
Manual transmitters exclusively	36	9	6	12	8	1
Automatic transmitters exclusively	13	1	3	6	2	1
Both manual and automatic transmitters	12	4	4	3	......	1
Receiving registers, all kinds	115	30	26	34	19	6
Receiving circuits	120	32	27	34	21	6
Transmitting circuits	112	28	25	33	21	5
Both receiving and transmitting circuits	112	28	25	33	21	5
Telegraph switchboards exclusively	24	3	9	6	4	2
Telephone switchboards exclusively	56	17	9	18	11	1
Both telegraph and telephone switchboards	14	9	3	2	......	......
Single circuits exclusively	28	3	3	5	11	6
Central station power equipment:						
Motor generators and dynamotors	11	7	1	2	1	......
Battery cells—						
Primary	94	22	19	20	24	9
Storage	74	18	20	23	11	2
Both primary and storage	24	6	9	5	3	1

[1] One system reported only telegraphing boxes, which are not shown in this table.

Of the 148 systems considered, 57 used both overhead and underground wires; of these, 28 were in the first population group, 11 in the second, and 10 in the third, or a total of 49 in cities of 25,000 population and over. There were 125 systems which reported signaling boxes only, 19 which reported telephoning boxes only, and 3 which reported both signaling and telephoning boxes. Of the 112 systems using both receiving and transmitting circuits, 28 were in the first population group, 25 in the second, and 33 in the third; and of the 12 systems reporting the use of both manual and automatic transmitters, 11 were in the first three groups. With regard to the power plant, it is interesting to note that 94 plants reported the use of primary batteries, and 74 reported their dependence upon storage batteries; a much larger proportion for the latter than could possibly have been expected. Although, as already noted, only 19 systems reported the use of telephoning boxes exclusively, and 3 the combined use of signaling and telephoning boxes, 56 reported the use of telephone switchboards. It would appear upon the face of it, that such figures must involve discrepancies, but in many of the systems in large cities the boxes are of a combination signal and telephone type, and were reported as signaling boxes only, thus vitiating to a great extent a comparison between the number of telephone boxes and the telephone calls shown in the tables. This fact accounts also for reports of telephone messages or switchboards in cases where there are no returns of telephoning boxes or special telephones.

Table 15 shows the miles of conduit and the wire mileage for the police patrol systems using underground construction, 57 cities being enumerated in 21 states and the District of Columbia.

TABLE 15.—UNDERGROUND CONSTRUCTION OF ELECTRIC POLICE PATROL SYSTEMS, BY STATES AND CITIES: 1902.

STATE OR CITY.	STREET MILES OF CONDUIT.		WIRE MILEAGE.		
	Owned.	Leased.	Total.	Single wire.	Single wire in cables.
United States	271	502	9,011	264	8,747
California	15	15	193	43	150
Los Angeles		5	28	28	
San Francisco	15	10	165	15	150
Connecticut	17	16	62	58	4
Hartford	8		10	10	
New Britain	1		1	1	
New Haven	8	16	51	47	4
District of Columbia	1	6	760		760
Washington	1	6	760		760
Illinois	56	2	646	2	644
Chicago	54		638		638
Elgin		1	2		2
Evanston	2		4	2	2
Rockford		1	2		2
Indiana	7	5	58	2	56
Fort Wayne		1	5		5
Indianapolis	7	4	53	2	51
Iowa		1	2		2
Davenport		1	2		2
Kansas		3	27		27
Wichita		3	27		27
Maine		4	16		16
Portland		4	16		16
Maryland		50	200		200
Baltimore		50	200		200
Massachusetts	22	108	583	102	481
Boston	6	36	315		315
Brookline		16	45	26	19
Cambridge		1	3		3
Clinton		1	2		2
Fall River		9	47		47
Holyoke		5	9	1	8
Lowell		5	39		39
New Bedford	6		22	6	16
Newton		2	9	4	5
Quincy	10		20		20
Springfield		12	40	40	
Waltham		2	5		5
Worcester		19	27	25	2
Michigan	22		273		273
Detroit	20		260		260
Grand Rapids	2		13		13
Minnesota	2	23	358		358
Minneapolis	2	3	200		200
St. Paul		20	158		158
Missouri	4	10	505		505
St. Joseph		10	50		50
St. Louis	4		455		455
Nebraska		3	22		22
Omaha		3	22		22
New Jersey		11	86	2	84
Newark		9	84		84
Paterson		2	2	2	
New York	7	60	584		584
Albany		4	20		20
Buffalo		20	97		97
Elmira		5	12		12
New York[1]	7	18	440		440
Rochester		13	15		15
Ohio		32	208		208
Akron		1	23		23
Canton		1	2		2
Cincinnati		20	158		158
Cleveland		10	25		25
Pennsylvania	85	137	4,224	53	4,171
Allegheny		84	252		252
Erie	1		3		3
Philadelphia	75	53	3,905	53	3,852
Pittsburg	9		64		64
Rhode Island	1	10	68		68
Newport		5	13		13
Providence	1	5	55		55
Virginia		6	14		14
Norfolk		1	4		4
Richmond		5	10		10
Washington	2		2	2	
Seattle	2		2	2	
Wisconsin	30		120		120
Milwaukee	30		120		120

[1] Has 4 separate systems, but is treated as 1 system.

The 57 systems shown in the table owned 271 street miles of conduit and leased 502 miles in addition. The total wire mileage underground was 9,011 miles, of which 8,747 miles were single wire in cables, and the remaining 264 miles consisted of single wires strung separately.

Table 16 presents the statistics of police patrol systems by states.

Table 16.—ELECTRIC POLICE PATROL

	State or Territory.	Number of systems.	Character of construction.										Number and character of boxes or signaling stations.					
			Overhead.					Underground.					Signaling.			Telephoning.		
			Miles of pole line.		Wire mileage.			Street miles of conduit.		Wire mileage.								
			Owned.	Leased.	Total.	Single wire.	Single wire in cables.	Owned.	Leased.	Total.	Single wire.	Single wire in cables.	Total.	Number on poles or posts.	All other.	Total.	Number on poles or posts.	All other.
1	United States....	148	829	3,187	17,339	14,296	3,043	271	502	9,011	264	8,747	9,476	6,747	2,729	1,170	1,060	110
2	Alabama	2	......	25	50	50	......	......	......	......	......	......	65	65	......	......	......	......
3	California	3	75	96	1,094	1,069	25	15	15	193	43	150	850	750	100	50	50	......
4	Colorado	2	30	49	139	139	......	......	......	......	......	......	117	21	96	......	......	......
5	Connecticut	6	2	64	112	108	4	17	16	62	58	4	147	143	4	......	......	......
6	Delaware	1	......	60	140	136	4	......	......	......	......	......	44	44	......	......	......	......
7	District of Columbia	1	(1)	(1)	(1)	(1)	(1)	1	6	760	......	760	307	261	46	200	200	......
8	Florida	3	2	20	53	53	......	......	......	......	......	......	54	54	......	11	11	......
9	Georgia	4	39	61	165	145	20	......	......	......	......	......	105	86	19	45	44	1
10	Illinois	12	113	326	1,753	1,750	3	56	2	646	2	644	1,327	282	1,045	......	......	......
11	Indiana	4	7	109	275	275	......	7	5	58	2	56	165	144	21	......	......	......
12	Iowa	3	4	42	65	58	7	......	1	2	......	2	43	26	17	26	26	......
13	Kansas	1	......	4	11	8	3	......	3	27	......	27	......	......	......	10	10	......
14	Maine	2	......	16	46	46	......	......	4	16	......	16	51	48	3	......	......	......
15	Maryland	1	5	15	300	300	......	......	50	200	......	200	260	260	......	......	......	......
16	Massachusetts	28	17	488	1,145	766	379	22	108	583	102	481	1,257	978	279	62	50	12
17	Michigan	5	34	38	397	397	......	22	......	273	......	273	346	290	56	......	......	......
18	Minnesota	3	18	100	573	573	......	2	23	358	......	358	229	137	92	......	......	......
19	Missouri	3	80	107	2,101	2,042	59	4	10	505	......	505	......	......	......	490	483	7
20	Montana	1	......	13	25	25	......	......	......	......	......	......	27	27	......	......	......	......
21	Nebraska	1	......	40	74	53	21	......	3	22	......	22	......	......	......	46	8	38
22	New Hampshire	1	......	2	2	2	......	......	......	......	......	......	7	7	......	......	......	......
23	New Jersey	8	62	161	2,772	463	2,309	......	11	86	2	84	457	452	5	17	17	......
24	New York	[2]14	28	455	1,651	1,488	163	7	60	584	......	584	938	653	285	47	44	3
25	North Dakota	1	......	2	2	2	......	......	......	......	......	......	......	......	......	8	7	1
26	Ohio	11	20	324	721	683	38	......	32	208	......	208	680	530	150	82	62	20
27	Oregon	1	......	12	24	24	......	......	......	......	......	......	25	......	25	......	......	......
28	Pennsylvania	11	240	299	2,934	2,932	2	85	137	4,224	53	4,171	1,228	983	245	25	25	......
29	Rhode Island	3	1	64	186	180	6	1	10	68	......	68	168	168	......	23	23	......
30	South Carolina	1	2	20	55	55	......	......	......	......	......	......	54	54	......	......	......	......
31	Tennessee	1	......	11	35	35	......	......	......	......	......	......	18	17	1	......	......	......
32	Virginia	2	4	18	52	52	......	......	6	14	......	14	27	27	......	28	......	28
33	Washington	2	3	45	93	93	......	2	......	2	2	......	153	146	7	......	......	......
34	Wisconsin	6	43	101	294	294	......	30	......	120	......	120	327	94	233	......	......	......

[1] Not reported.

[2] New York city has 4 separate systems, but is treated as 1 system.

SYSTEMS, BY STATES: 1902.

Special telephones.	POLICE CALLS RECEIVED OR SENT.		CENTRAL OFFICE EQUIPMENT.											Single circuits.	CENTRAL STATION POWER EQUIPMENT.				
			Transmitters.		Receiving registers, all kinds.	Receiving circuits.	Transmitting circuits.	Telegraph switchboards.			Telephone switchboards.				Motor generators and dynamotors.		Battery cells.		
	Telephone.	All other.	Manual.	Automatic.				Number.	Number of sections.	Total capacity.	Number.	Number of sections.	Total capacity.		Number.	Horsepower.	Primary.	Storage.	
1,998	23,393,812	17,232,693	83	30	439	1,272	983	70	84	578	187	224	3,055	28	18	18	24,477	11,317	1
......	......	15,800	......	......	2	10	4	......	......	......	1	6	8	......	......	......	75	35	2
50	95,208	782,131	2	......	13	50	28	7	11	51	2	2	120	......	......	......	5,665	356	3
12	605,400	......	......	......	9	9	2	1	1	10	1	1	20	1	......	......	47	150	4
29	96,814	269,010	......	1	4	59	59	2	2	8	7	51	100	1	......	......	484	206	5
......	(1)	(1)	3	1	2	3	3	......	......	......	......	......	......	......	......	......	50	450	6
......	1,226,400	212,671	1	2	3	30	14	......	......	......	2	3	250	......	1	1	......	906	7
2	13,961	13,735	1	1	2	6	6	1	4	4	1	1	4	1	......	......	145	38	8
2	247,055	426,873	2	2	4	16	10	2	2	8	......	......	......	......	......	......	125	236	9
......	4,224,866	250,490	3	1	101	101	22	......	......	......	47	4	161	5	1	1	1,999	793	10
......	60,384	453,916	1	1	4	15	3	2	5	16	1	5	50	2	......	......	112	314	11
7	158,758	169,660	1	1	6	32	32	......	......	......	......	......	......	......	......	......	52	180	12
......	56,039	......	1	......	......	10	10	......	......	......	1	1	20	......	......	......	20	......	13
14	......	241,727	......	1	3	6	5	......	......	......	1	1	5	......	......	......	110	96	14
15	876,000	295,101	......	......	18	43	24	1	1	8	19	19	43	......	......	......	1,218	......	15
252	1,673,872	6,069,828	15	5	54	114	121	7	7	29	16	19	141	3	8	3	2,465	1,876	16
41	1,254,020	26,505	1	1	27	25	24	......	......	......	3	3	45	2	2	2	204	561	17
38	157,634	162,375	1	......	11	160	147	4	4	36	8	8	224	......	......	......	96	220	18
259	1,510,288	588,216	9	1	9	58	27	15	15	185	3	3	185	1	1	1	1,759	282	19
3	(1)	(1)	1	......	1	4	1	......	......	......	1	1	5	......	......	......	......	50	20
1	219,000	4,856	......	......	5	4	......	......	......	......	1	1	20	......	......	......	......	150	21
......	......	5,475	......	......	1	7	......	......	......	......	......	......	......	......	......	......	......	......	22
29	231,306	890,584	14	......	18	51	35	8	8	50	3	3	30	1	......	......	1,268	474	23
279	1,541,134	3,819,003	8	1	39	123	113	4	7	45	11	24	719	2	2	2	3,578	1,292	24
......	54,750	......	......	......	......	......	......	......	......	......	......	......	......	1	......	......	......	......	25
71	1,392,904	771,534	2	2	22	102	84	4	4	26	8	9	239	1	2	7	738	221	26
......	......	175,200	......	......	1	3	......	......	......	......	......	......	......	......	......	......	100	......	27
799	6,901,355	705,962	9	2	52	96	86	9	10	76	44	47	397	2	......	......	2,478	1,261	28
18	106,382	693,635	7	4	2	67	64	......	......	......	1	1	4	1	......	......	1,349	......	29
......	2,778	87,424	......	......	1	3	3	......	......	......	1	1	4	......	......	......	......	62	30
4	......	73,000	......	1	1	4	4	......	......	......	1	1	50	......	......	......	140	......	31
1	1,225	892	......	......	4	7	7	1	1	4	1	1	6	......	......	......	50	60	32
40	5,444	71,320	1	1	8	14	14	1	1	12	1	5	100	......	......	......	40	446	33
32	680,835	5,770	......	1	12	40	31	1	1	10	1	3	105	4	1	1	110	602	34

The 148 police patrol systems were distributed in 32 states and the District of Columbia. Massachusetts is credited with the largest number, 28; New York comes next with 14; but in the latter case it should be noted that New York city, which has 4 separate systems, is counted as only 1 system. Illinois has 12 systems; Ohio and Pennsylvania, each 11; New Jersey, 8; and Connecticut and Wisconsin, each 6. It appears from the table that the number of police calls sent or received by telephone was 6,901,355 in Pennsylvania, and 4,224,866 in Illinois, the state next in rank. The large proportion in Illinois is due to the extensive use of the telephone in the city of Chicago. In 1902 New York had 938 signaling and 47 telephoning boxes, and 279 special telephones, with which 5,360,137 calls or messages of all kinds were sent or received; but, as noted elsewhere, since the time of this report the borough of Manhattan has contracted for no fewer than 661 police patrol stations, to be operated in conjunction with the local telephone system. It is to be noted, in fact, that the number of special telephones reported in 1902 was considerably larger than the number of telephoning boxes specifically described as such, but it has already been explained that a considerable number of systems reporting signaling boxes used a combination system of signaling and telephoning.

The foregoing table indicates that most of the police patrol systems are located in those states having the greatest number of large cities; but it is probable that the extension of the telephone throughout the rural districts has made greater progress than appears from the figures here presented, for it is a matter of record that the use of the farmers' telephones in rural districts has greatly lessened the labor of sheriffs and constables in connection with suppressing the "tramp nuisance."

HISTORICAL AND DESCRIPTIVE.

The utilization of the telegraph as an aid in the detection and suppression of crime, and also in connection with other duties falling to the protectors of the peace, was quite early resorted to by the police departments in various large cities. In fact, one of the very earliest instances of the use of the telegraph in England—and that which did most to direct public attention to it at that time—was the forwarding from one city to another of a telegram describing an escaped murderer, who was promptly arrested by means of the assistance thus given. In the leading American cities the practice early took root of employing telegraph operators at headquarters, as members of the force, to transmit messages and receive signals over wires connected with the police stations in the various precincts. In 1858 the firm of Charles T. & J. N. Chester made for the New York city police department a dial telegraph, which soon afterwards was adopted also by Philadelphia.

It is obvious, however, that this practice, if based simply upon Morse telegraphy with the use of the key and sounder, or even with the aid of the Morse register, would involve an undue and expensive staff of operators, and these conditions could not be greatly improved even by the use of the dial system, wherein the operation of an electrical apparatus with a keyboard something like that of a typewriter enables a message to be sent directly in letters of the alphabet, thus avoiding the necessity of first translating them into dots and dashes and then having them translated back again. In the case of fire alarm telegraphs, a mere notification by numerals suffices to give the required alarm and bring prompt assistance; but in the case of police patrols, the facts transmitted in each case are so varied in character as to require specific details, and even the brief delay of putting a message into the Morse code or into a cipher would consume too much time.

Under these circumstances it was natural that resort should be had to the telephone; and the evidence goes to show that the combination of the telegraph and telephone as an auxiliary to the police force was first introduced in 1880 in the city of Chicago by Mr. J. P. Barrett, then superintendent of the electrical department of that city. The system was first installed in one of the most turbulent districts of the city, and at once increased tremendously the efficiency of the force, chiefly in the way of making possible a rapid concentration at any troubled point. Its success was so rapid that by 1893 no fewer than 1,000 street stations had been installed all over the city of Chicago, and in addition several hundred private boxes had also been put in, giving instant communication, at any hour of the day or night, with all the stations of every precinct. Since that time the idea has been carried even farther in various ways, as the accompanying report shows, not only in Chicago, but in other cities. Milwaukee was the second city to adopt the police telephone booth, the installation being made in 1883. Brooklyn followed in February, 1884, with many improvements, which appear to have been made there for the first time. Upon the suggestion of Mr. Frank C. Mason, superintendent of the police telegraph bureau, iron boxes, similar to those employed in fire alarm telegraphy, were used instead of the unsightly booth. Philadelphia, however, adhered to the booth, introducing it in July, 1884; since that time the system has been extended year by year, and some of the more modern street boxes have been introduced.

As the work in Chicago is typical, and is the fundamental form from which the others have been evolved, a brief description of it may be given. A special feature was the adoption, for street stations, of an octagonal booth or inclosure about 8 feet high and 2 feet 4 inches in diameter. For many reasons such sentry boxes are preferable to boxes on walls or lamp-posts, as the patrolman once within is secure from interruption while communicating with headquarters, and, moreover, the intelligence he wishes to convey can be kept secret—a

matter of considerable importance on many occasions. Keys which will open any of the street stations and boxes are given to the patrolmen of the district, and are also placed in the hands of responsible citizens, the names of the citizens and the numbers of the keys being carefully recorded. The citizen's key only turns in a call for help, but the patrolman's key gives him access to the inner box, from which he can transmit calls, signals, and reports, by means of telephone receivers and transmitters and other apparatus.

The private boxes placed in residences, banks, hotels, etc., enable the persons using them to call up the police at any time by simply turning in an alarm; by pulling the lever or handle attached to the box, as in the case of the district messenger boxes, the nature of the trouble can be indicated roughly. At the police station is kept, under seal, a key of the house employing the signal box, so that upon arrival the police can immediately let themselves in and proceed to business. Each night, the renter of the alarm box can make a test of the system, an answering ring showing the line to be in working order; in the same way, after an alarm has been sent in, a return tap signal of the bell gives assurance that the call has been heard and will be attended to immediately.

Notwithstanding the advantage of being able to carry on a conversation by telephone, there is a certain advantage in automatic signaling, as there can be no variation, and no wrong idea can be conveyed by an excited dispatcher to a confused operator at central who can not understand what is being said.

In addition to the telephone system and the automatic signals, visual signals were introduced. Semaphores were used by day and flash lights by night, by utilizing either ordinary lamp-posts or lamps placed on top of the booths; an additional feature was the ringing of a large bell. Not only are the visual signals used as a means of registering the proper circulation of patrolmen on their beats, but they have this advantage—they can be operated on all the boxes on any one circuit.

The systems of the present day are analogous to that which has just been outlined, the signal box being provided with a telephone, by means of which patrolmen can communicate with police headquarters. The telephone is supplemented, however, by other apparatus for signaling and telegraph purposes. For example, with one type of box the patrolman advises the central office of his being on duty by opening the box with a special key, thus transmitting the number of the box, which, with the time, is recorded automatically upon a slip of paper by an electric time stamp. These signals are transmitted at a higher rate than fire alarm signals, for the reason that no heavy apparatus, such as a gong, is used. These signals may be said to correspond in their nature to those of a watchman's automatic registering system, being received by the central office mechanically, without intervention of an operator. The mechanism of the box is so arranged that when a signal requiring immediate attention is sent in, a local circuit is closed by a bell magnet, thus calling special attention to the incoming signal. A further modification makes it possible, in case an officer on the beat has requested the dispatch of a police wagon or ambulance, to convey or transfer the signal to the stables; in this event the call is transferred by the operator to the dial mechanism communicating with the stables, a lever is pulled, and the number of the box is sent over the circuit to the stables, where it is both struck by the gong and exhibited visually on an indicator.

As already stated, police patrol boxes are sometimes fitted with two keys, and the boxes ordinarily in use in the large cities are of this type. Such boxes usually have both an outer and an inner door, the object of the outer one being generally to limit the extent to which the private citizen can utilize the box. When the key has once been put in the "citizen" keyhole and turned, it can not be withdrawn until the outer door has been opened, whereupon the signal is transmitted to headquarters. The patrolman on his rounds opens the doors, and, if he wishes merely to report his presence there, places the point of the small dial at the top of the plate inside at the "report" section, when an answering signal within the box will inform him that his report has been received at headquarters and that he may proceed on his rounds. Should it be desired by "central" to hold him for instructions, a definite number of strokes on the bell notifies him to use the telephone, which hangs in the inner box. This signal can be sent to any box, even in the absence of the central office attendant, thus obviating the possibility of the policeman getting away before the special call can reach him.

Another form of box is fitted with the keyless door, which can be opened by any citizen desiring to use it, the turning of the handle sounding an alarm on a gong and thus notifying any policeman at another box on the same beat that it is in use. In some systems provision is made whereby the patrolman is unable to prevent the box from keeping automatically a faithful record of his movements; for instance, a policeman could not remain at one box and from there, at the proper time, send in false signals purporting to come from other boxes at different points on his beat. It is obvious that many other modifications and changes can be introduced, according to local requirements and conditions, but the features here outlined are those which are most generally used at the present time.

A remarkable proof of the enlarged scope given the service by the use of the facilities of the modern telephone exchange is afforded by the latest development of the telephonic police signal system recently put in operation in the city of New York. This system was determined upon early in 1903, after several conferences between Prof. G. F. Sever, consulting electrical engineer on behalf of the city, and the representatives

of the New York Telephone Company, held at the office of Police Commissioner Greene. It was decided to install in the borough of Manhattan no fewer than 661 police telephone stations, from 20 to 30 in each of the 29 police patrol precincts. After a careful and thorough investigation it was decided to eliminate from this system all signal appliances aside from the telephone itself, it being held that everything provided for in the ordinary combination signal and telephone box, and much more, could be done through the telephone station.

A station consists of a telephone transmitter and receiver and a call bell placed in a cast iron box securely fastened to the wall of a building; six of these telephone stations comprise one circuit. Each patrolman is provided with a key, and is required to report to the station house at a designated time in each hour; if he is delayed more than fifteen minutes a roundsman is detailed to investigate the reason for the omission of the call. It is held that there is no possibility whatever of turning in an improper report, as the operator at the central station, who knows all the men, can always recognize the voice of the patrolman, and can determine from the signal the box from which the call is made.

In the station house in each precinct there is installed a small switchboard operated by specially detailed patrolmen. The operator at this switchboard records the box and the time at which each patrolman reports, as well as all other messages in the nature of ambulance and patrol wagon calls, reports of riots, and other exceptional occurrences; he also telephones to police station stables for patrol wagons and to hospitals for ambulances.

One improvement which it is thought may be desirable is the abolition of the circuits having telephones in series groups of six, in favor of a system in which each instrument is on a separate metallic circuit, and is provided with two individual wires, as is generally the case in the modern telephone system in every large city. This arrangement would absolutely eliminate the possibility, if there is any, of collusion on the part of patrolmen with regard to reporting at the proper time but at a different box from that at which the call should be turned in.

All the work of installation, maintenance, and operation, outside of that of the operator at the switchboard, is looked after by the New York Telephone Company, the police department paying an annual rental for the use of the apparatus. This arrangement obviates the necessity for the maintenance by the police department of a corps of skilled men to maintain and operate such a signal system as would, under ordinary circumstances, be owned by the city; and it virtually places at the command of the police department all the resources of a modern telephone exchange with its engineering staff. It is impossible to make any estimate of the results obtainable with this system, which at the time of writing has been installed in but one precinct, and it still remains to be seen whether it is not better for the city to maintain its own apparatus and staff.

With regard to the subject of ambulance alarm circuits in hospitals and public institutions—a branch of the work still in a somewhat unorganized condition—it would appear that in New York city almost all ambulance calls are sent in from either public or private telephone stations; a patrolman sends the call to the central police headquarters in Mulberry street, whence it is transmitted to the hospital nearest the scene of accident or trouble. The city fire alarm circuits also are sometimes used for sending in ambulance calls to fire headquarters, whence they are transmitted by telephone either to the nearest hospital or to police headquarters, as, for example, when a fire chief, being near the scene of an accident, avails himself of the facilities of his department in securing prompt relief.

SPECIAL FEATURES.

The tables and statistical matter presented in this report deal with a great variety of apparatus; in the course of years, however, the essential features have been standardized, so that the differences in practice are of a minor character, such as belong rather to the minutiae of technique than to questions in which the public is interested, and hence need hardly be noticed in a report of this character. The apparatus referred to is essentially a manufactured product, bought in the open market, usually under competitive bids, but a great many of the departments have their own repair shops, many of which do work of an extensive character; for example, at San Francisco the repair shops under the department of electricity not only attend to all general repairs, but manufacture all the signaling devices used on the system.

The statistics have also brought out the fact that the systems are so overwhelmingly municipal in ownership and operation as to render it unnecessary to make a separate classification of those under private ownership. It may be noted, however, that some of the systems have been installed under conditions of peculiar or special arrangement with local service companies. The system at West Chester, Pa., for example, was installed and is kept in operation and repair by the Edison Electric Illuminating Company without expense to the town. At Deadwood, S. Dak., the system was installed, without cost to the city, by the Black Hills Electric Light Company. In a great many instances current for operating the services is furnished by local lighting or street railway companies, either for the exclusive operation of the plant or as a supplement to the power

plant belonging to the system. It is interesting to note that the current for charging the storage batteries of the Buffalo fire alarm system is obtained from the power company at Niagara Falls, over twenty miles away. At Carbondale, Pa., the storage batteries of the system are charged with 500 volts current from the Scranton Street Railway Company's power plant. At Lawrence, Mass., the current is reported as being furnished by the local electric light company.

In connection with the fire alarm system at Detroit, Mich., it is reported that a portable pocket telephone, plugging into a suitable jack, is used to communicate from the fire alarm boxes with the central office, the receivers and transmitters being in series. This device is stated to have been used satisfactorily for the past five years.

In Atlantic City, N. J., it is stated that 90 per cent of all night fire alarms are now turned in by the police officers, as compared with 10 per cent previous to the establishment of the police patrol system. Of the 38 cities having 100,000 or more inhabitants, 20 did not use manual or automatic transmitters in connection with their police patrol systems.

Rochester, N. Y., claims to be the first city in the United States to install on all police telephone circuits a central energy telephone system—that is, a system in which all the energizing and operating current is furnished from the central exchange, as in modern telephone practice in the larger cities; the signaling circuits of this system are operated without using ground connections, condensers, or other paraphernalia in the patrol boxes. Rochester claims also that it was the first city in New York state to adopt a police telegraph system. Its police telegraph boxes are supplied with a special system of cut-outs, as a protection against being burned out by abnormal currents. In this connection it may be noted that the fire alarm system at Portsmouth, N. H., has obviated the blowing out of fuses, frequently occasioned by the proximity of heavily charged cross wires, by detaching the ground wires from all boxes and other apparatus, excepting the one used in connection with the testing switches. At Millbury, Mass., the trouble caused by lightning striking the fire alarm circuits has been obviated by a relay so adjusted that the least excess of current cuts in an emergency set of batteries. Other instances of variation and of special effort to improve the efficiency of the two systems might be enumerated.

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